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Industrial Evolution

HOW many of the products and processes accepted as matters of course today would have been not only impossible but inconceivable a few years ago!

Each new discovery and invention opens out a whole line of possible developments with ramifications in unseen directions.

How many of the things that have become basic in the present system of things would never have been dreamed of without the possibilities that the past century and a half has developed in the generation and transmission of power from fuel!

How much of our advancement in domestic comfort and convenience, in transportation, in communication, in localizing the application of power in communities, shops and factories; in optics and surgery and physics, would have been possible without the comparatively recent development in electricity?

For how many of the materials now available in the carrying out of these processes are dependent upon the development in chemistry and metallurgy, themselves dependent for their commercial realization upon power and electricity!

The process of converting the energy of steam to useful forms of power by the turbine was understood and applied in a small way perhaps as early as was the more cumbersome displacement - engine method, but how utterly impossible would have been the production of a modern high-speed turbine with the material, tools and mechanical ability of the times of Boulton and Watt!

It has long been obvious that steam of high pressure and temperature could generate all the power required to drive a works by its expansion to what a few years ago were regular boiler pressures, but with the exception of a few daring experimenters like Perkins, who would have dared?

The horizon is gradually receding. Each year our view is getting broader and our field and its possibilities larger. We are not only advancing, but climbing to heights the view from which is unimaginable.

F. R. Low

The Belvedere Starts Its Power Plant Again

By HENRY E. NELSON*

BALTIMORE'S leading hotel finds it can generate energy cheaper than it can be purchased—Uniflow cylinders installed on single-valve engines reduce steam consumption—Motor-driven pumps replace steam-driven units to provide better heat balance

FREQUENTLY, a hotel or other building shuts down its power plant and uses purchased energy with an apparent marked saving. Customarily, the saving is credited to the shutdown of the generating units, when, in fact, investigation would often reveal that the re-arrangement and modernization of the auxiliaries have been responsible for the reduced cost of power. The management is satisfied with the decrease in operating expenses and seldom is inclined to check the cost with that of operating the hotel's own plant, after the improvements in the auxiliaries have been made.

In the case of the Belvedere Hotel, after seven years of buying its electrical energy, the generating units were started up, and with more efficient operating conditions, several thousand dollars are saved yearly over the cost when buying energy.

The Belvedere, when built in 1902, was equipped with a complete power plant. In the boiler room were three 3,000-sq.ft. horizontal water-tube boilers, one fitted with a side-feed inclined stoker and two with shaking grates. The boiler-feed pump was the typical steam-driven duplex type.

The engine room held three single-valve high-speed engines, direct connected to 110-volt direct-current generators. The largest was rated at 200 kw., the second at 150 and the smallest unit at 100 kw.

The elevators were of the hydraulic type, and three steam-driven duplex pumps were used to supply the water needed. For the house service there were two duplex steam-driven pumps, along with one of the same type for sump purposes and two simplex steam-driven vacuum pumps to maintain a vacuum on the heating system. In addition, a steam-driven fire pump was in the engine room. For refrigerating purposes a 35-ton absorption system, taking live steam, was installed.

In 1913 it was decided to shut down the power plant and buy electric energy, the boilers being retained for heating purposes. In changing over, the steam-driven pumps enumerated were discarded and motor-driven units installed. A triplex pump belted to a motor replaced the boiler-feed pump. For elevator service three motors direct-connected to 3-stage centrifugal pumps were substituted for the old steam pumps; two 2-stage centrifugal pumps, direct-connected to 35-hp. motors were installed for the house service and a centrifugal vacuum pump driven by a 2-hp. motor was placed on the heating returns, while a single-cylinder power pump driven by a 2-hp. motor replaced the steam sump pump.

The absorption refrigerating system was abandoned for a 35-ton compression system, the compressor of which was chain-driven from a 75-hp. motor. The brine was handled by two 2-stage centrifugal pumps driven by 35-hp. motors. Since the hotel was supplied from a 220-volt direct-current main, all the motors were of this voltage.

The same labor was used as formerly, since much of the time of the plant force was spent in the repairs and alterations to the plumbing and heating systems.

The rate schedule was: First 500 kw.-hr., $0.045 per kw.-hr.; next 4,500 kw.-hr., $0.025 per kw.-hr.; next 4,500 kw.-hr., $0.010 per kw.-hr.; balance, $0.009 per kw.-hr.

The demand was based on 181 kw., making the month's charge $397. In addition, the coal clause increased the cost per kilowatt-hour amounts varying from 0.39 to as high as 0.83c., according to the variation in the cost of coal.

Every effort was made to reduce the cost of operation, the public utility even supervising the boiler-room force.

The new arrangements show a saving over that obtained by the former operation of the plant. The cost of coal and electric current during the year 1922, when current was purchased, was as follows:

Electric current	1,228,430 kw.-hr.	$24,138.96
Bituminous coal	1,661.42 tons	14,563.58
Anthracite screenings	860.40 tons (long)	
Gas	3,045,000 cu.ft.	1,943.14
		$40,645.68

The amount used each month was:

	Light, Kw.-Hr.	Power, Kw.-Hr.	Bit. Coal, Tons	Screenings, Tons	Gas, Cu.Ft.
January	39,820	44,540	253.19	114.00	258,600
February	38,690	52,230	175.54	115.00	279,100
March	36,980	51,330	147.28	106.00	265,300
April	40,880	65,160	99.99	94.00	286,000
May	40,970	71,660	83.75	109.00	307,000
June	35,500	69,060	74.75	31.00	235,300
July	34,150	71,520	76.94	19.00	185,400
August	31,230	63,510	54.60	16.00	180,700
September	35,030	78,050	61.25	29.40	234,700
October	38,280	75,440	143.75	62.00	259,600
November	41,690	75,070	194.00	96.00	292,900
December	31,530	66,110	296.38	69.00	261,400

However, in 1923 it was decided to try the generating

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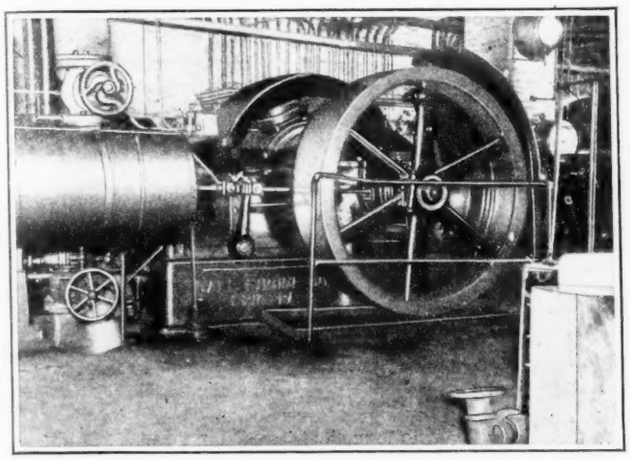
units upon the lighting load, which amounted to about one-third of the total hotel energy demand. The voltage of the generators was 110, which precluded carrying the motor load on the engines. Even with so small a plant load a saving was made and, apparently, a large reduction in the cost of power was possible if the entire load could be placed on the engines. These single-valve units were satisfactory during the winter months, when all the exhaust was used for heating, but were extravagant when operating with atmospheric exhaust during the summer. It was determined to replace the cylinders of the 200- and the 150-kw. units with dual clearance piston-valve uniflow cylinders. The small engine was not changed, as it was to be used for emergency only. The generators were rewound to give 250 volts at the



100-kw. single-valve engine converted into a uniflow

terminals, this being cheaper than the replacement of the 220-volt motors or the installation of a motor-generator set.

After completion of the alteration, the plant was placed in commission. The operation has been successful to a marked degree. During the year Nov. 1, 1924, to Nov. 1, 1925, the current generated totalled 1,214,740 kw.-hr. Coal for the laundry, kitchen and boiler room amounted to 4,185 tons. The records by months show the separation of the coal for the several departments.

	Current, Kw.-Hr.	Power Plant — Coal, Tons	Power Plant — Cost	Laundry and Kitchen — Coal, Tons	Laundry and Kitchen — Cost
January	105,910	352.50	$2,115.00	46.50	$279.00
February	98,040	279.50	1,629.24	42.00	244.76
March	105,500	319.25	1,883.58	46.50	279.00
April	98,790	303.40	1,796.62	45.00	267.92
May	102,600	300.40	1,697.26	46.50	279.00
June	95,790	281.20	1,574.72	45.00	267.92
July	91,960	279.00	1,562.40	46.50	260.40
August	89,300	279.00	1,562.40	46.50	260.40
September	95,940	274.50	1,537.20	45.00	267.92
October	109,550	317.50	1,778.00	46.50	260.40
November	118,020	303.00	1,818.00	45.00	252.00
December	103,340	348.50	2,091.00	46.50	279.00
Total	1,214,740	3,637.75	$21,045.42	547.50	$3,131.98

In comparing the cost with purchased power, the labor item may be ignored, as it is the same in both cases. The fuel cost and electrical energy charge are the only items of any moment, and the electrical cost figured is based on the new schedule offered.

	If Purchased	By Power Plant
Electrical energy, 1,214,740 kw.-hr.	$21,119.88	
Coal and gas	16,506.72	$24,177.40
Breakdown service		3,044.00
Total	$37,626.60	$27,221.40
Savings by plant operation		$10,399.20

The only charges that could be made against this particular plant are depreciation and interest on the cost of the alterations, for the space occupied by the generating units is quite small and could be used to no advantage by any other department. As there was invested $25,000 in making the change, interest and depreciation at 15 per cent would amount to $3,750, which still leaves a saving large enough to justify this company to operate its isolated plant.

The saving made possible, as compared to the old system of using steam-driven auxiliaries and inefficient engine cylinders, is due chiefly to the better heat balance and to economy for the uniflow cyinders.

Cooling Towers at Nechells Station

In view of the discussions that have resulted from certain recommendations in the Giant Power Survey as to locations for mine-mouth power plants, the following information with reference to the cooling towers installed at the Princes Station Nechells, Birmingham, England, should prove pertinent.

The capacity of this station on normal rating is at present 75,000 kw., in five units, and the ultimate capacity will be 105,000 kw. Each of the units is capable of carrying 18,750 kw., so that on overload rating the present capacity of the station is about 94,000 kw.

The condensers are served by thirty-five wooden cooling towers, but this number will be increased to forty-five when the station is finally completed. Each tower is 100 ft. high above the level of the pond over which it stands and is capable of dealing with 200,000 gal. of water per hour. Water entering the tower averages 95 deg. F. and leaves at 75 deg. F., these temperatures varying with the season. The vacuum varies between 28½ and 28 in.

The circulating water used is purified sewage effluent obtained from the filter beds of the Sewage Disposal Works situated some little distance from the station. There is ample supply of this purified effluent for "makeup" purposes. There is now being planned a much larger station to serve the needs of this city, which will also be equipped with cooling towers and use sewage effluent as circulating water.

According to the operating force the sewage effluent has no deleterious effect on the condenser tubes or on any of the pipework, and the upkeep of the wooden cooling towers is almost negligible. The wood is, of course, creosoted under pressure before the towers are erected.

The November, 1925, number of *Labor and Industry*, the bulletin published by the Department of Labor and Industry, Commonwealth of Pennsylvania, states that 66 employees were killed last year and more than 15,000 were injured because, contrary to law and the rules of the company, they attempted to clean, adjust, oil, reset or repair machinery while in motion. It is a self-evident fact that adjustments or changes should not be made while the machinery is in motion.

Heavy oils, like engine cylinder oil derived from engine exhaust or otherwise finding its way into a boiler are more likely to cause burning and bagging than light oils like kerosene. Kerosene acts as a preservative against rust, but is likely to cause leakage at joints, and when carried over with the steam into the piping system, causes leakage of rubber gaskets and most kinds of soft packings.

Checking the Accuracy of Watt-Hour Meter Connections

ONE of the most important conditions in meter installations is to have the meter correctly connected. In this article some of the likely connection errors and methods of detecting these are pointed out.

BY WILLARD F. WALSH
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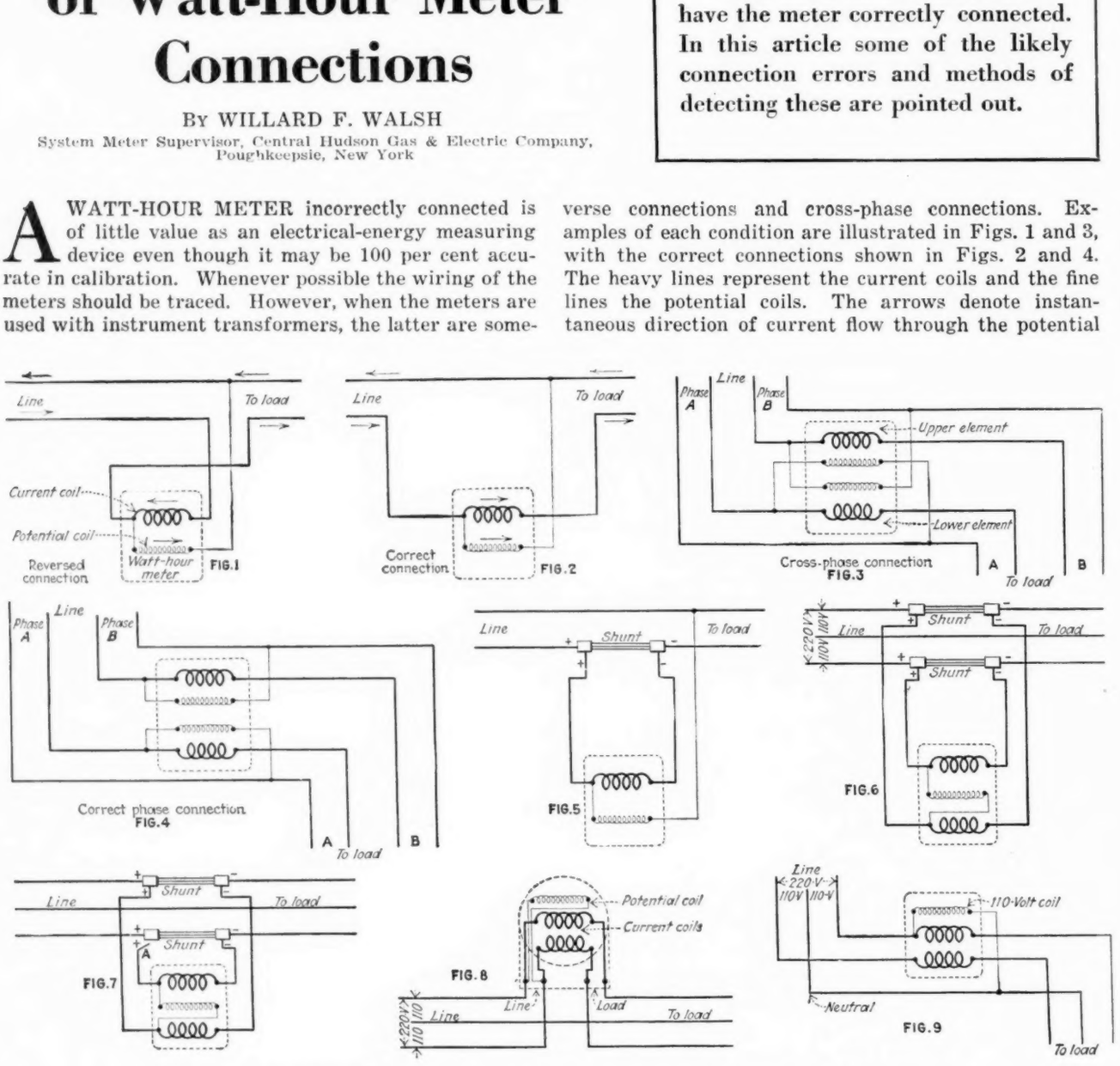
A WATT-HOUR METER incorrectly connected is of little value as an electrical-energy measuring device even though it may be 100 per cent accurate in calibration. Whenever possible the wiring of the meters should be traced. However, when the meters are used with instrument transformers, the latter are sometimes placed in an iron casing and immersed in oil and the wiring to the meter run in metal conduit. Oftentimes, in switchboard-meter installations the back of the switchboard is so congested that it is impossible to trace the wiring from the transformers to the meter unless the power is shut off. In such cases it is necessary to resort to some other method of checking the wiring connections.

Throughout this article reference will be made to reverse connections and cross-phase connections. Examples of each condition are illustrated in Figs. 1 and 3, with the correct connections shown in Figs. 2 and 4. The heavy lines represent the current coils and the fine lines the potential coils. The arrows denote instantaneous direction of current flow through the potential and current coils of each element. To cause correct direction of rotation of the disk, the current in the two coils must be in the same direction, as in Fig. 2, and not in opposite directions, as in Fig. 1.

A meter is cross-phased when the potential coil of one element is connected to a different phase from the current coil of the same element, as illustrated in Fig. 3. In Fig. 3 the current coil of the upper meter element and the potential coil of the lower element are connected



Figs. 1 to 9—Alternating-current and direct-current watt-hour meter connections

Fig. 1—Single-phase watt-hour meter with current coil reversed. Fig. 2—Single-phase watt-hour meter correctly connected. Fig. 3—Two-phase watt-hour meter with its potential coils cross-phase connected. Fig. 4—Two-phase watt-hour meter correctly connected. Fig. 5—Two-wire direct-current watt-hour meter connections. Fig. 6—Three-wire direct-current watt-hour meter connections. Fig. 7—Method of testing three-wire direct-current watt-hour meter to see if both elements are connected to give correct rotation. Fig. 8—Three-wire single-phase watt-hour meter with a 220-volt potential coil. Fig. 9—Three-wire single-phase watt-hour meter with a 110-volt potential coil, connected between the middle and one outside leg.

to phase *B*, while the potential coil of the upper element and the current coil of the lower element are connected to phase *A*. The correct connections are shown in Fig. 4.

Direct-Current Meters

As a rule it is comparatively simple to install a direct-current meter either with or without a shunt. Practically all meter terminals are marked "Line" and "Load," which serve as a guide in the connecting of the meter. Therefore it is only necessary in the case of a meter without a shunt to connect the power source leads to the "Line" side of the meter and the load leads to the "Load" side. When using a shunt on a two-wire meter, it is customary to connect a source lead to the + terminal of the shunt and to connect the + lead of the shunt to the "Line" side of the meter, as in Fig. 5. Of course if the meter is not correctly connected, the disk will rotate in the reverse direction, which should be readily noticed.

When connecting a three-wire meter with two shunts, the + terminals of both shunts should be connected to the 220-volt source wires and the + leads of the shunts should be connected to the line side of the meter, as in Fig. 6. It is possible to have one of the current coils of a three-wire meter connected reversed, but this would generally result in practically no registration unless the load was greatly unbalanced, in which case the meter might show either a forward or a backward rotation with corresponding registration. This condition can be readily ascertained by disconnecting one shunt meter lead, as at *A*, Fig. 7, noting the direction of rotation and then reconnecting it and removing the other shunt meter lead. The disk should rotate forward in either case if the meter is connected correctly.

Single-Phase Meters

A single-phase two-wire meter contains one current coil and one potential coil, as in Figs. 1 and 2, and therefore it can only be connected to run either forward or

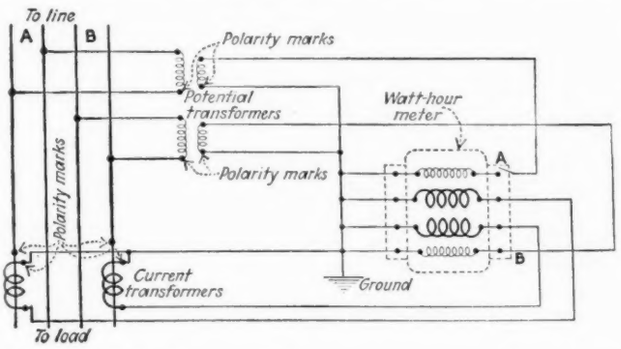


Fig. 10—Polyphase watt-hour meter connected to a two-phase circuit through transformers

backward. A three-wire meter has two current coils and one potential coil. Some meters have a 220-volt potential coil which is connected across the line by being tapped on the current coils inside the meter, as in Fig. 8. These taps are generally made through a test loop on to the current coils. However, some of the older types of three-wire single-phase meters have a 110-volt instead of a 220-volt potential coil. In this case it is necessary to connect one side of the potential coil to the neutral wire of the three-wire system, as in Fig. 9.

When connecting a single-phase meter to instrument transformers, the polarity marks of the transformers govern the direction of disk rotation. The transformers have one primary lead and one secondary lead marked white, making it possible to know the relative instantaneous direction of current in the leads. Current that enters a white primary terminal of a transformer is considered as coming out of the white secondary terminal.

The current and potential coils of meters intended for use with instrument transformers have independent

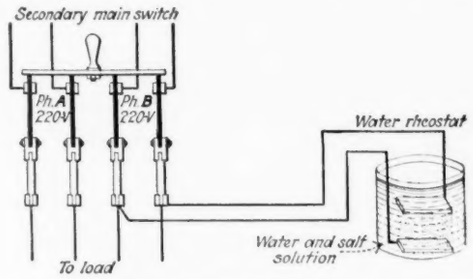


Fig. 11—Method of loading one phase of a polyphase watt-hour meter

terminals. Here again it is necessary to know the voltage rating of the potential coil of a three-wire current-transformer meter before connecting it to the line, as some meters have 110-volt potential and some have 220-volt coils.

Two-Phase Meters

There are two checks to be applied to a two-phase meter which is connected to current and potential transformers; namely, for reversal of rotation and for cross-phase connection. Whether or not the load is balanced on each phase, each element should always show forward rotation. This condition can be checked under load by first opening one of the potential circuits to the meter and noting the direction of disk rotation, which should be forward. This can be done by disconnecting the potential lead from the upper potential coil as at *A*, Fig. 10. Then reconnect lead *A* and disconnect lead *B*, and the rotation should again be forward. If in either case the disk rotates backward, the potential leads to the element that causes backward rotation should be reversed. It is unlikely, however, that a two-phase meter would be found with one element reversed, because under such a condition the dial would show very little registration unless there was considerable unbalance in the load, in which case to give an increase in the meter reading, the heavily loaded phase would have to be the one that was connected so as to produce forward registration.

Assuming that the potential coils of the meter are not open-circuited, the meter can be checked for cross-phase by short-circuiting the current transformer in phase *A* at the transformer terminals and opening the potential transformer secondary in phase *B* at the secondary terminals. The meter should practically stop if it is not cross-phased, because the current circuit of one element is short-circuited and the potential circuit of the other element is open-circuited. However, this test sometimes cannot be carried out very easily because the transformers are not always accessible, or the high voltage conditions are such as not to permit one to get near enough without danger. This test should not be attempted on circuits over 2,300 volts. If it is possible to

shut the load off for a short time, a test for cross-phase can be made with a water rheostat connected across one phase of the secondary, as shown in Fig. 11. With

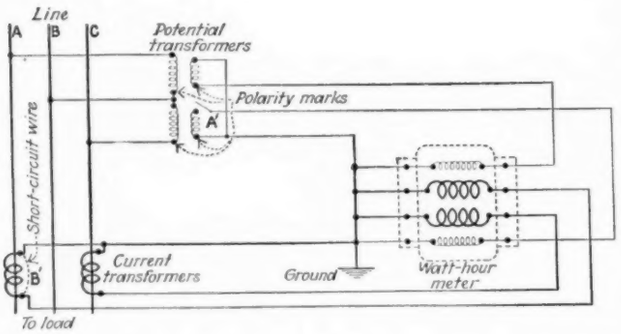


Fig. 12—Polyphase watt-hour meter connected to a three-wire three-phase circuit through transformers

such a load the disk will not rotate if the meter is cross-phased, but will go forward if the phases are correct. This method can also be used to check for a reverse condition by connecting the water rheostat to each phase separately.

A check for reverse and cross-phase connections can also be made on a three-wire three-phase circuit with a water rheostat in the same manner as in the two-phase circuit. Of course there should be no other load on the meter when using this method. Also, the meter can be checked for cross-phase connection as in the case of the two-phase meter by short-circuiting the current transformer in phase *A* at the transformer terminals and opening the potential transformer secondary in the other phase, at the secondary terminals, as indicated in Fig. 12, at *A'* and *B'*. As noted previously, this test should not be applied to a circuit of over 2,300 volts.

If the potential transformers have taps in the windings, voltmeter readings should be taken across the secondaries to see that the right voltage tap is connected to the meter. A voltmeter also serves well to check blown potential-transformer fuses. The secondary circuit of a current transformer should never be open-circuited. If it is necessary to open the current-coil circuit, the current-transformer secondary coil should always be short-circuited first as a safety measure for both the transformer and the person working on it.

Submarine Engines in Stationary Service

IT IS seldom that the propelling machinery outlasts the hull of a vessel. However, this has occurred with some of the navy submarines. Certain classes of the earlier boats were engined with 120-hp. four-cylinder air-injection Diesels turning at 350 r.p.m. The boats outlived their usefulness and were finally junked, but the Diesels had performed satisfactorily and were in excellent condition. It was deemed in keeping with the economical trend of the government to find further duty for them.

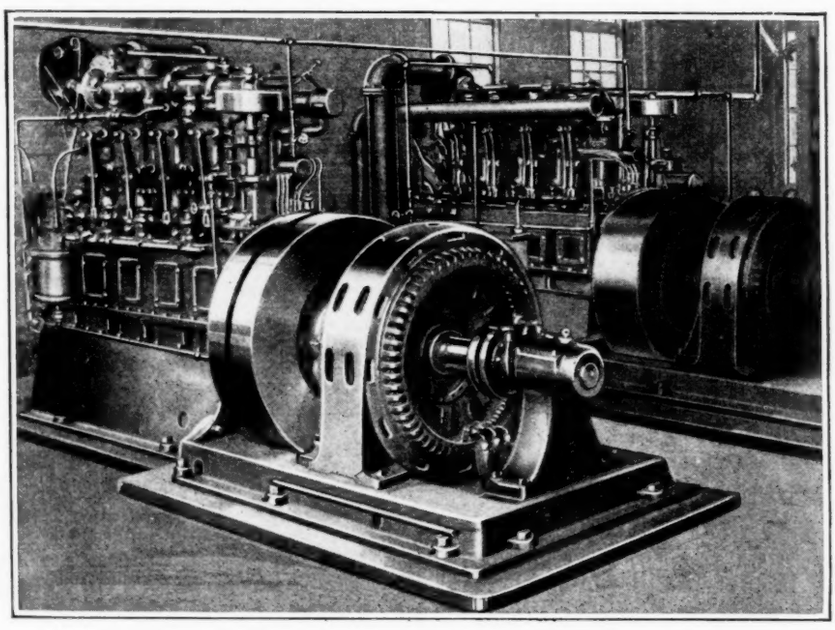
At the mine-loading station near Yorktown, Va., the lighting was being supplied by gasoline-engine generating sets scattered about the 1,100-acre reservation. It was decided to abandon these isolated units and construct a central power plant to serve all the buildings. A brick and steel structure was erected, and three of the 120-hp. Diesels were installed. Since the electric lines were of some extent, alternating current seemed necessary. Consequently, each engine was fitted with a new sub-base extended to accommodate a 90-kw. 2,300-volt three-phase alternator.

For excitation a 15-kw. motor-generator set is used, and as breakdown a gasoline engine direct connected to a 25-kw. direct-current generator was installed. Each engine is provided with its own three-stage compressor, mounted at the end of the engine frame, but an emergency three-stage compressor direct-connected to a two-cylinder gasoline engine was added as a safeguard.

The fuel oil is stored in a large tank and lifted to the engine service tanks overhead by one of three rotary pumps direct connected to ½-hp. motors. The circulating water is obtained from a pond and is forced through the engine jackets either by a centrifugal or by a double-acting power pump, both of which are direct connected to motors.

The plant uses 32-deg. Baumé Diesel fuel oil, and no serious operating trouble has occurred. A little difficulty has been experienced with the compressor valves, due, by outward appearance, to too much lubricating oil. As installed on shipboard, the engines had only emergency governors. These were replaced by standard engine governors which regulate the speed by varying the closure of the pump suction valves.

The plan is one that might be followed advantageously in other branches of the government.



Two of the three submarine Diesels

Modern Oiling Devices for Inclosed Refrigerating Machines

Limitation of Splash System—Oiling by Inertia—Pressure Feed Systems

BY TERRY MITCHELL*

IT FORMERLY was standard practice to lubricate the working parts of inclosed ammonia compressors, in all except the largest sizes, through the splash system. However, the oil splashed by the cranks was not sufficient to lubricate the piston pins, and there was always a danger of hot pins unless provision was made for some method of independent oil feed.

A number of designers have fitted their machines with special oil pumps, attached to the lower ends of the connecting rods and arranged to force the oil up to the wristpins through small pipes, as shown in Fig. 2. The upflow of oil through the tube

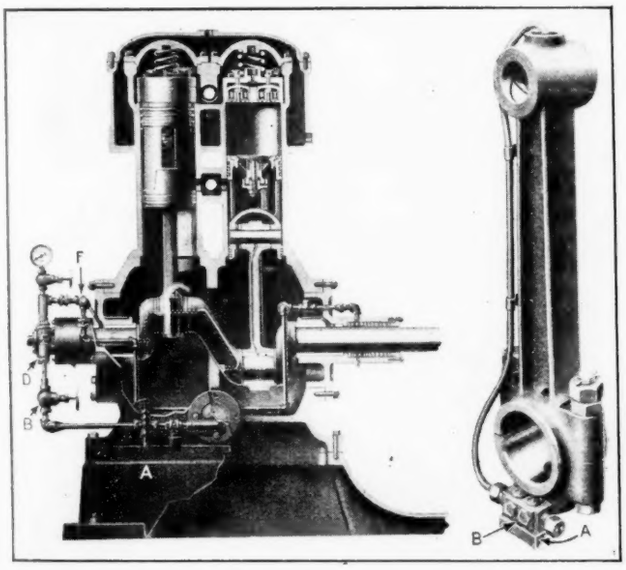


Fig. 1—Compressor with pressure oiling system
Fig. 2—Method of oiling piston pin

is accomplished through the inertia of the oil in the crankcase. At the moment the end of the connecting rod rotating about the crankpin strikes the oil in the crankcase, it is moving in a counterclockwise direction. The oil entering through the opening *A* lifts the check valve *B* and is forced by following particles of oil to flow up through the pipe to the piston-pin bearing. With the improvement in design of the bearings and pins this combination of the splash system and positive lubrication for the upper end of the connecting rod worked very well and is now to be found on thousands of inclosed refrigerating machines.

On compressors with capacities of 20 tons or more, the higher speeds in use today have made the adoption of a still more positive oiling system desirable. Equipped with the modern geared oil pumps and other lubricating equipment, inclosed compressors are now available for heavy duty against high head pressures such as are encountered in tropical countries.

The latest systems of lubrication will also play an important part in making automatic plants more reliable, as well as in relieving the minds of operating engineers of any worry about correct and continuous oiling for the machines in their care.

In planning the new system, it was of course an advantage to have the improvements fit the existing types of compressors without expensive or questionable modifications. A number of special conditions had also to be taken into account: The system must work equally well when the compressor is run in either direction; external oil pots and belt-driven pumps must be avoided if possible; provision must be made for adding oil to the system without stopping the machine, regardless of its direction of rotation; and the correct oil pressure must be maintained under changing ammonia pressures and compressor speeds. Furthermore, the oil fed to the shaft stuffing box should be under a lower pressure than that supplied, for instance, to the wristpins and cranks. The drive for the pump should be positive, yet flexible enough to allow for variations in the position of the shaft. There should be no possible chance for the pump or oil passages to become gas-bound; a reasonable amount of oil must be conveyed to the walls of the cylinders; end thrust on the shaft due to oil pressure, must be avoided, and the good features of the ordinary splash system must not be lost.

Two Systems of Forced Lubrication

To meet these requirements, two general systems of forced lubrication have been brought out—the "pipe-line" system and the "oil-spray" system, the latter being especially suited to big machines. On small compressors the spray system would tend to coat the cylinder walls too heavily with oil, leading to the trouble known as oil pumping.

In either system the crankcase of the machine serves as an oil reservoir, the connecting rods dipping into the oil and furnishing splash lubrication to the pistons. The oil pump, consisting chiefly of two gears and double sets of ball check valves, is mounted on the end of the main-bearing housing. A hole is drilled into the end of the shaft, off center enough so that the inserted pin when engaged with the small crank will drive the pump. By making the crankpin a loose fit in the hole, wearing-in of the shaft causes no pump trouble.

On both systems a pocket for an oil screen is cored out of the compressor frame at the bottom of the crankcase. The oil is drawn into the pump, Fig. 3, through a pipe *C* connected to the screen and curved

*Frick Ice Machine Co.

to conform to the shape of the machine frame. The oil-suction pipe has both a drain valve *A* and a shutoff valve *B;* this last is for use in stopping the normal flow of the oil when a fresh supply is being fed into the system.

The oil pumps have double-suction and double-discharge passages, each with the necessary ball checks, to enable the pumps to function when turned in either

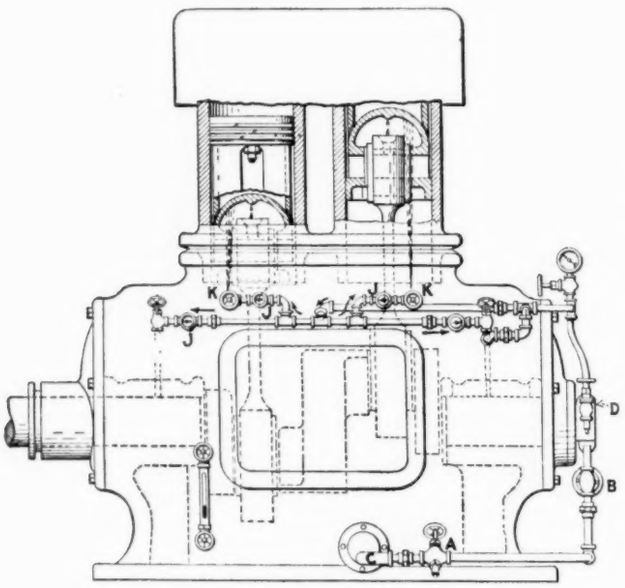


Fig. 3—Oiling devices on large compressor

direction. Two small valves *D* are mounted on the pump; one is to relieve any gas pressure above the pump when first starting the machine or when taking in new oil, and the other is for admitting the makeup oil, through a hose. The letters on Fig. 1 correspond to those on Fig. 3.

Just above the oil pump is a gage, to show the oil pressure. After passing the gage connection, the path of the oil is divided, a part of it going to the main oil lines and the rest passing through a relief valve *F*, made adjustable through the action of a spring. From this point onward, the pipe-line system differs so much from the spray system that the two will be discussed separately.

Referring to Fig. 1, it is seen that the oil, as it comes from the pump, passes through a hole drilled in the bearing housing, and lubricates the main bearing directly. At the same time, a hole extending straight through the main journal of the shaft is kept in constant communication with the oil under pressure, by means of a groove on the inner surface of the babbitt of the bearing itself. The oil enters the passages in the shaft, and is conducted to the cranks, the oil line being bridged across the central web of the shaft by means of a curved external pipe, with the ends welded to the oil holes near the crankpins.

The wristpins receive their share of the oil in a series of rapid spurts, two for each turn of the mainshaft. The impulses that cause this spurting action of the oil occur every time one of the oil holes in the crankpin passes under the pipe leading up the side of the connecting rod. The arrangement furnishes a supply of oil under full pressure to the crank and wrist pins in turn, rather than having both bearings work under a reduced oil pressure, which might prove insufficient with heavy loads.

As the capacity of the pump is greater than is necessary to force oil into the shaft system, a good volume of the lubricant passes through the relief valve and is led to the opposite main bearing and the shaft stuffing box. An open tee, located just above the bearing, permits the excess oil to overflow, in this way flooding the bearing, and draining the oil back into the crankcase. In the stuffing box a special oil lantern is provided, in the form of a spring; this automatically takes up the expansion and contraction of the packing, under variations of temperature. The use of a relief valve makes it possible to keep the oil pressure at about 15 lb. above the gas pressure in the crankcase, in spite of fluctuations in the suction pressure or in the speed of the machine. With this design the stuffing box is also relieved of any direct oil pressure.

In the spray system, Figs. 3 and 4, the pipes are all outside of the compressor frame, and sight-flow indicators *J* are inserted at convenient points. A pair of nozzles *K*, inside the crankcase, are so placed that they direct a steady spray of oil up into the dome of each piston. A small deflector at the top of the dome causes some of the oil to run down into the cup in the connecting rod; a second portion of the oil stream lubricates the cylinder walls, and another cup in the lower part of the rod catches oil for the crank-end bearing. In addition, a large hole is left open at the extreme bottom end of the rod, to allow the oil in the crankcase reservoir to enter the bearing freely. Separate pipes carry the oil to the main bearing caps. All four of the oil outlets are under the control of valves.

About the only danger to be feared with a force-feed system of lubrication is that the oil may be pumped

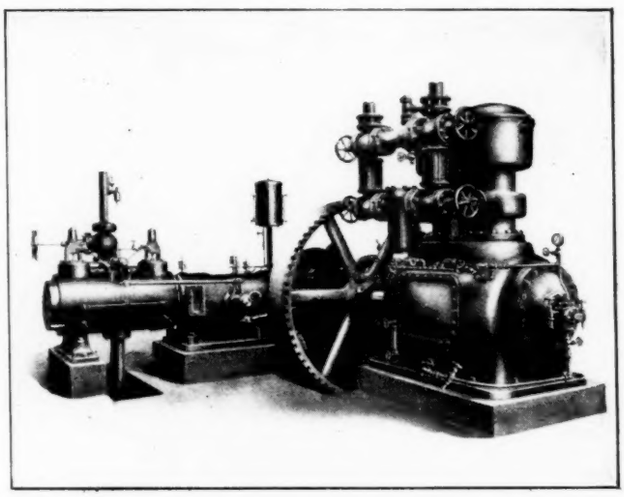


Fig. 4—Compressor using oil sprays for the pistons

out of the crankcase and into the condenser or evaporating coils of the plant, where its presence as a hindrance to heat transfer would be objectionable. As a preventive of oil pumping, special scraper oil rings are fitted to the lower part of the piston, with holes drilled through the piston skirt, behind the first ring, to drain off the excess oil. It is also well to have an oil-collecting groove turned near the bottom edge of the piston, the groove being drained by a second series of holes.

Photo by Kaufmann & Fabry Co.

Main entrance to the Exposition Palace, where the Midwest Power Show was held

Midwest Power Conference Meets All Expectations

A GREAT success was the universal verdict of those attending the Midwest Power Conference held at the Furniture Mart Building, Chicago, from Jan. 26 to 29. Bringing into co-operation the six engineering bodies previously indicated in these columns, the Conference presented an excellent example of what may be done by co-operative effort concentrating on one phase of engineering of common interest. The success of the first movement of such magnitude in this section will, no doubt, lead to others of a similar character, which will become a unifying factor for the profession in the Midwest division.

The general topic was "Power," which was discussed in its various phases, including generation by steam, water, oil and gas. Some twenty papers on timely topics of utility and industrial interest were presented by authorities of national prominence.

There were perhaps too many papers crowded into the limited time available, curtailing the discussion to some extent, but the intent was to give the utmost to those taking four days of a working week to attend. The quality of the papers and the completeness of all arrangements throughout the conference are to be highly commended.

Attendance was limited for the most part to engineers of the Middle West. Registration reached a final figure of approximately 1,200, and at the various sessions from 500 to 700 were present at each sitting. To make the meeting representative, each session had a different chairman, from one of the participating associations or from a different city in the district represented.

An exposition of power equipment and apparatus was held simultaneously in the same building. Although under distinct management, it was available to those attending the conference, and, by exhibiting the latest developments in the field, added materially to the educational advantages to be derived. Details are given elsewhere in this issue.

Power Developments in the Mississippi Valley

On Tuesday, the opening day of the conference, the morning was occupied by registration, at noon the pressing of a button at Washington by the Hon. Herbert Hoover officially opened the Power Show, and in the afternoon the conference was on, with W. L. Abbott, president of the American Society of Mechanical Engineers, as chairman. The entire session was devoted to an introductory address on "Power Developments in the Mississippi Valley," and it was only fitting that the

speaker should be Samuel Insull, the man who has had most to do in this development and who is in control of the great network of interconnected systems covering this area.

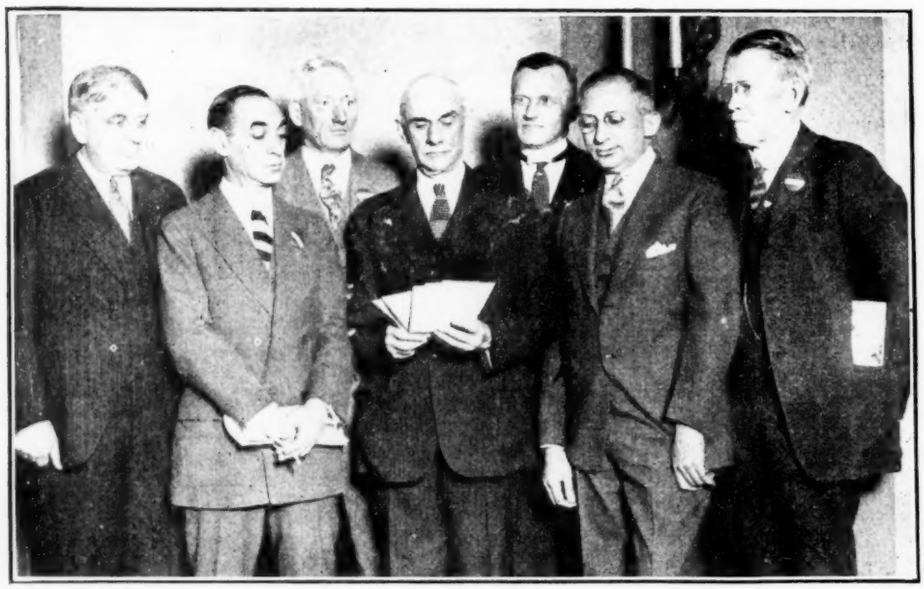
Included in the territory on which Mr. Insull based his remarks were the ten states bordering on the Mississippi, and Michigan, Ohio, Alabama, Kansas, Oklahoma and Texas, an area of 1,142,000 square miles, covering 38 per cent of the country and containing 43 per cent of the nation's wealth, its value being $137,000,000,000. From this section came 53 per cent of the oil produced in the United States, 42 per cent of the lumber, 78 per cent of the cotton, 73 per cent of the corn and oats and 51 per cent of the wheat and rye. With 138,000 miles of steam railways, this section had 52 per cent of the total in the country and with over 50,000,000 people had 48 per cent of the population.

In a rapid review of its steam and water power developments, Mr. Insull gave statistics showing that this section developed 37 per cent of the total power generated in the country, notwithstanding its inclusion of large areas devoted to agriculture. Exclusive of the power used on farms and steam railways, the United States had 45,000,000 hp. and the Mississippi Valley 17,000,000 hp. Of these totals the electrically operated power was 34,000,000 and nearly 13,000,000 hp., respectively, or about 75 per cent.

Of the total potential water power in the country available 50 per cent of the time and at an efficiency of 70 per cent, 10,000,000 hp. out of a possible 55,000,000 hp. had been developed. The Mississippi Valley had only a small percentage of that power, 5,500,000 hp., and of this 1,800,000 hp. had been developed. This was equivalent to 18 per cent of the developed water power of the country, or 32 per cent of the possible water-power development in the area of the Mississippi Valley.

From the first central plant in the Midwest District at Appleton, Wis., which antedated by a few weeks only the starting of the original station in New York, and the first organized effort in Chicago in 1888, Mr. Insull traced the development of the central station in the Middle West, pointing out the marked influences that had led to the great advance of recent years. He briefly sketched the present status of the light and power business and the great extent to which interconnection had been carried in this territory. Quotations from his numerous speeches made during the last thirty years showed that he had always visualized and urged development in the direction of greater concentration, the building of large efficient plants and finally their interconnection into vast systems to reduce the cost of the product and eventually the rates for service. The business was a natural monopoly and notwithstanding the present policies and legislation, eventually all electrically energy in a given area must be produced by one company under proper control, if the greatest economy was to be obtained.

In the Mississippi Valley 85 per cent of the systems, involving fourteen major companies, are now interconnected and in 1924 the energy sales amounted to $525,000,000. Here also is the longest interconnected system of transmission lines under one management, measuring 730 miles from end to end.



Group of engineers prominent in Midwest Power Conference, consisting of session chairmen and authors of papers: Left to right—James H. Herron, C. F. Hirshfeld, L. F. Harza, W. L. Abbott, H. Birchard Taylor, B. F. Lyons, D. W. Mead

Looking into the future, Mr. Insull predicted that if the 130,000 miles of steam railways in the Mississippi Valley were electrified, the requirements would be 24 billion kilowatt-hours a year, or almost the equivalent of the present utility output in this section, and the saving in coal would amount to 75,000,000 tons a year out of the 93,000,000 tons now used by the railways. If all the farms in the district under discussion were electrified, rather than the present 6½ per cent, the rural load alone would increase the present central-station output 50 per cent. Adding to this the business that will come from increased population, prosperity and purchasing power, it appeared that public utilities were only on the threshold of the great development that is coming in this industry.

Water Power and Interconnection

Wednesday morning was devoted to water power and interconnection. B. F. Lyons, president of the Great Lakes Section of the National Electric Light Association, was the chairman. Prof. Daniel W. Mead, of Madison, Wis., in discussing the "Water Power Resources of the United States," pointed out the uncer-

tainties in getting an estimate of available resources because of the insufficiency of surveys that had been made and the lack of accuracy in classification as to value for commercial development. He showed how estimates of power available are made, pointed out discrepancies in work that had been done and in general made it clear that estimates of the undeveloped water powers of a nation were of little use because of lack of detailed information and its expression in comparable units. Power that would be commercially available immediately or at an early date could be determined only by a detailed study of markets, transmission and development costs and existing legal restrictions and entanglements. From United States Geological Survey estimates, the total potential horsepower of the various states was given and the installation of turbines in seventeen states having over 86 per cent of the total turbine capacity installed. Recognizing the need for greater and more exact knowledge of the water resources of the country, the speaker favored support for the Newton bill, which is favorably regarded by the American Engineering Council.

Limited discussion on this paper turned to the low heads available, the advance that had been made in turbine design, and, with the great improvements that also had been made in steam plants, the difficulty of designing a low-head water plant that would show equal commercial efficiency.

Changing Viewpoints in Turbine Practice

Under the title, "Changing Viewpoints in Hydraulic Turbine Practice," H. Birchard Taylor, of Philadelphia, president of the Pelton Water Wheel Co., called attention to the fact that many accepted principles of twenty years ago are now recognized as fallacies, and principles then neglected are considered of controlling importance. As an example, two factors formerly emphasized were avoidance of sudden changes of section in the turbine conduit and the elimination of high velocities to reduce skin-friction loss. The importance of the first factor has become more evident, and it is now realized that the principle must be applied to the flowing stream as well as the conduit, when the flow does not utilize the full area provided. The author discussed the effect of these considerations on the design of the casing, runner and the draft tube, and considered the effect of the vortex principle in the spiral casing design, the need of adequate blade area in high-speed runners, the avoidance of undue flare of the conduit at the runner and the use of improved forms of draft tube.

Mechanical features of design, such as the discarding of complex, inaccessible and unlubricated mechanisms, were considered, attention was given to vibration, water hammer, cavitation and pitting, and mention made of developments in impulse turbine design, such as the double overhung arrangement of wheels, rigid nozzles, improved bucket construction, draft tubes and vertical setting for large units.

Although at times the hydraulic prime mover seems to have approached standardization, it refused to remain standardized, and it was the author's opinion that the present forms of reaction and impulse turbines would not remain fixed. Development was dependent on research and the competition at the present time made adequate research impossible, so that every hydraulic plant was in a degree experimental.

Following the paper, the author was asked for information regarding the principles of the Hydraucone, or equivalent construction, and the possibility of recovery of power by its use over that of an efficient design of straight draft tube.

In a paper giving "Suggestions Regarding Hydraulic Plant Operation," L. F. Harza pointed out that hydraulic stations, in general, had certain advantages that recommended them for contributory service to a steam-power transmission system, even in the Middle West, where steam is and always will be the predominant source of power in most districts. Having provided a dam with all its incidental costs, it was his contention that the strictly power generating station with its intakes, penstocks, machinery and building, could be built more cheaply than a steam station per unit of capacity for heads of about 25 ft. or greater, assuming the capital investment in the steam station to be $125 per kilowatt. For a head of 50 ft. the hydraulic generating station costs about two-thirds that of the steam station, and for a head of 100 ft., the cost is less than one-half as much, based upon general average conditions.

Another contention, contrary to general opinion, was that if a hydraulic station was justified on the basis of its annual energy output on a competitive basis with the average steam cost of a given system, then a hydraulic station could be provided with excess capacity for serving peak loads more cheaply than the steam capacity of the system could be increased for this peak-load service.

Combined Operation of Steam and Hydraulic Systems

One of the difficulties of combined operation of steam and hydraulic systems was the conflict and jealousies arising between operators unless operation was under one man of remarkable impartiality and in continuous hourly contact with the conditions existing on the entire system. The value of complete operating records and the fact that these records can be obtained at little or no additional cost was emphasized and comments made on accuracy in predicting flow, the use of the hydraulic unit during periods of low stream flow as synchronous condensers for power-factor correction and the manning of automatic stations, particular reference being made to the one-man station in which one man per shift cares for the strictly operating duties, leaving the general maintenance to the certain number of helpers determined by the type of the station and the conditions of operation.

Discussion following emphasized the importance of accurate records of stream flow and the desirability of manufacturers supplying suitable information in curve form on the operation of their equipment. At the present time highly efficient machines were seldom operated to the best advantage.

R. F. Schuchardt, of the Commonwealth Edison Company, summarized the superpower survey that has been made by the Great Lakes Division of the National Electric Light Association. Of the nine states involved, Illinois, with 7,100, had the greatest number of intercity lines and used 730 kw.-hr. per capita. The generating capacity of the Chicago region was 1,150,000 kw. and the per capita use 1,050 kw.-hr., as compared to 865 for New York City. By 1950 it was predicted that the per capita use of electrical energy in the Great Lakes District would approximate 2,000 kw.-hr.

In the final paper of the session on "The Extension

of Power Service to Rural Communities," G. C. Neff, chairman of the N. E. L. A. Committee on Rural Electric Service, Madison, Wis., reviewed the early use of power in rural communities for grist mills, local factories and the like. The great improvement in the steam engine, followed by the development of the steam turbine and later the development of the local electric public utilities, made it possible to supply power in the larger cities at much less cost than in the smaller cities and villages. This condition helped materially to bring about a large industrial development in the large cities, and often this was done at the expense of the small communities where an adequate amount of low-cost power was not available. Then began the great expansion program of the public utilities whereby large efficient generating stations were built and connected by transmission lines, first to the larger cities, later to the smaller cities and recently to the small villages and farms, with the consequent tendency toward the decentralization of industry.

A review of the effects of electric light and power on the conditions of rural life and on the work of farming showed that it was possible for the American farmer to obtain higher production and higher income per worker and thus make for a higher standard of living on the American farm than is possible in foreign countries. Figures were given of the percentage of present service and distribution lines to those required for complete electric service to rural communities, and in this connection the financial problem was discussed as well as the work that is now being done to determine the best method of extending service and applying electric power in an intelligent and practical manner to agricultural operations.

In supplementing Mr. Neff's remarks, Prof. E. H. Lehman gave some interesting statistics from time and power surveys for different jobs on ten farms electrically equipped. He said the average monthly consumption per farm approximated 300 kw.-hr., or ten times the usual farm requirement, and a cost of $8 to $9 per month was about equal to that of keeping one horse. Dr. E. A. White voiced the opinion that the farm problem would be met when utilities gave the same attention to it that they had given to other phases of the business.

Electric Power Development in Chicago District

Wednesday afternoon, Homer E. Niesz, president of the Western Society of Engineers, was in the chair. The session was devoted to subjects of interest mostly to the large modern steam station. William S. Monroe, president of Sargent & Lundy, reviewed "Electric Power Development in the Chicago District" step by step from the inception of the first central station in 1887. Reference was made to each succeeding station, to the great extension in the transmission system, to the reduction in coal consumption as station layout and equipment design improved, the increase in size of units, the 130,000-volt tie lines around the city, the growth of Chicago load and power station-capacity in the Chicago District. For 1926 this is given as 1,164,165 kw. and the ultimate capacity as 3,897,000 kw. Far-reaching plans for power development in the Chicago district were outlined and analyses given of the possibilities for further reduction in the cost of energy through increased efficiency and lower investment in equipment and building. An interesting announcement for a future station was the contemplated use of three-cylinder compound units of 200,000 kw. capacity. More of this most interesting paper will be given in a later issue.

In an oral discussion on the burning of powdered coal, C. F. Hirshfeld gave a word picture of early developments, summarized the present state of the art and advanced a few surmises as to future development. Early experimenters tried to get too violent combustion and used furnaces that were too small. Enlarging furnaces and slowing combustion made it possible to burn coal successfully under boilers, but troubles still existed and these were heavy charges for furnace maintenance. Air-cooled walls was the next step, then water-cooled walls and other developments, each device serving to remove certain limitations to the use of pulverized fuel. Present considerations were toward the reduction of furnace size and cost, made possible by shorter flames, more rapid combustion and violent agitation to insure proper mixture of air and gases.

Personal observations of the speaker were to the effect that the unit mill was at least threatening the supremacy of the central system. To reduce investment there had been tremendous urge for its development. An elaborate study of results from stoker and powdered-coal plants, showed that when burning high-grade Eastern coals, the cost of making steam was practically the same. As the quality of the coal became poorer, the advantage of the powdered-coal system increased. It had greater flexibility with slight variations in the quality of the coal and a flatter efficiency curve.

Rather than inferior or waste coals, it will be found that the fuel used in the powdered-coal plant will be that giving the cheapest steam. Ofter this will be the best grade of coal within reasonable transportation distance.

As an educated guess of future developments, the speaker anticipated continued spread in the use of powdered coal for steam making, and also stokers of improved type, so that a choice would call for close figuring. Powdered-coal firing would be largely by the method using agitation within the furnace, unit mills would take precedence over the central system and coal giving steam at the lowest cost would be used rather than the nearest or cheapest fuel. Although not a cure-all, powdered coal would help to solve many difficult problems existing.

Supplementing Mr. Hirshfeld's remarks, E. H. Tenney gave an interesting summary of operating experience with the unit type mills, water-cooled furnaces and burner arrangement at Ashley Street Station, St. Louis. His remarks in detail will appear in a later issue.

Henry Kresinger gave as the reasons for large powdered coal furnaces, the necessity of keeping the walls away from the flame and slow combustion to protect the refractories. Water-cooled walls and more violent mixing made possible higher rates of combustion and a reduction in volume. Except for small boilers he was not so sure of the advantages of the unit method over the central system. The former would come into greater use in the next two yers, and when some of the faults were discovered that were not known now, it was his belief that the pendulum would swing in the opposite direction.

Byproduct Processing

"Byproduct Processing of Coal" was discussed at length by H. W. Brooks, consulting engineer, Fuller-Lehigh Co. Consideration was confined to but four primary byproducts of coal: fuel oil, motor fuel, rich

gas and ammonium sulphate, and for convenience the entire subject was divided into the following six classifications: Extraction by solvents, conversion of coal into oil by hydrogenation, conversion of coal or carbides into oil by gas synthesis, complete gasification, high-temperature carbonization and low-temperature carbonization. Of these subdivisions the first five were summarized briefly in order that more attention might be given to the specific treatment of carbonization at low temperatures, as this method offered greater immediate promise to the power-plant field.

Advantages of low-temperature distillation were enumerated at some length and different types of distillation apparatus were illustrated by lantern slides and discussed. These were divided into two classes, the first being heated externally, the heat being transmitted from outside through a wall, and the second heated internally, carbonization being directly effected by hot gases passing through the charge. The apparatus for external heating was further divided into stationary and rotary furnaces, the former being of the shaft type, horizontal type or tunnel kiln type.

Comment on each of the externally heated types was followed by a similar presentation on internal heating. In general attempts had been made to utilize four heating media: Superheated steam, hot producer gas, hot coke-oven gas and hot flue gases. Of the four, steam was the most suitable direct heat carrier, but the process gave little commercial promise and operation for complete tar recovery was expensive. Installations using hot producer gas and hot coke-oven gas were described and favorable mention made of carbonization by means of hot flue, or re-run, gases, as in the 200-ton McEwen-Runge commercial-scale experimental retort at the plant of the Milwaukee Electric Railway & Light Co. Here powdered coal is dropped into an internally heated tower where it will come in contact with an upward current of hot inert gas. The extremely large surface presented by the finely divided fuel particles insures a rapid transfer of heat, so that distillation is effected during the time the fuel falls from the top to the bottom of the tower, a distance of 30 ft. When using coals having a tendency to agglomerate, advantage is taken of the fact that by preheating the coal to an average temperature of 600 deg. F., the coking tendencies of the particles are destroyed. It is then passed through a second tower behind the first one, where the balance of the volatile matter is distilled by passage through a counter-current flow of gas at an average temperature of 1,050 deg. F. The gases and oil vapors are carried off to the scrubbing and cleaning apparatus, and the pulverized semi-coke is conveyed from the bottom of the tower to be burned under boilers in pulverized form.

Boiler Water Conditioning

One of the most comprehensive papers of the meeting was that given by Dr. R. E. Hall, physical chemist of the Bureau of Mines, Pittsburgh, on the subject, "Boiler Water Conditioning with Special Reference to High Operating Pressures and Corrosion." An extensive abstract appeared in the Feb. 2 issue, so that only brief mention need be made here.

Dr. Hall's paper summarized the conclusions of four years' research undertaken to establish the essential conditions for prevention of adherent scale and corrosion. Definite relations have been established between boiler pressure, sulphate concentration and the carbonate concentration needed to prevent scale formation. These concentrations are measured by simple apparatus suitable for boiler room use. Other matters of interest touched upon were the use of sodium phosphate in high-pressure boilers, prevention of corrosion and avoidance of excesses of CO_2 and other non-condensable gases.

Industrial Plant Design

Thursday morning J. H. Herron, of Cleveland, presided. In this session the industrial power plant was given an inning, as the first paper by Paul L. Battey, of Chicago, dealt with its layout and equipment, featuring in particular a balance of the factors involved such as thermal and investment efficiencies and the use factor of the equipment. No attempt was made to present figures as to efficiency values, but rather to set out relative values—the relation of factors—in such a manner that the entire problem might be visualized and a better co-ordination or balance be reached. It was the author's idea that balance of the factors involved was the answer to every engineering problem, leading to maximum effectiveness in any analysis.

In the design of industrial plants this problem of balancing involved far more diversified characteristics than was found in the power plant for commercial service. Not only must the power demand, diversity and consumption factors be obtained, but the requirements in terms of the above factors be determined for process steam, heating, air compressors, pumps for various other service systems, and these under all seasonal variations. Consideration also must be given to outside commercial power service for all or part of the load on a schedule extending over the entire year.

Emphasis was placed on the use factor as it reflected the economic aspect of investment, depreciation, taxes, insurance and to a certain extent, maintenance and labor. These items represented from 50 to 55 per cent of the cost of electric power production, while fuel, operating labor, supplies and most maintenance constituted the remainder. Of the latter, the fuel item varied from 25 to 35 per cent of the total cost. It was obvious that anything effecting 10 per cent increase in the use factor would show twice the over-all saving that 10 per cent reduction in fuel consumption afforded.

These ideas were amplified and illustrated and suggestions given on increasing the use factor by extending power-plant facilities and services within the factory, or by scheduling operations so that initial power-plant capacity might be minimized and a more nearly uniform load be maintained.

Consideration was given to types of prime movers, the capacity of individual units, the balancing of power and heating or process steam, the tendency toward decentralization of the industrial plant and to many other factors that will require attention in present or future development.

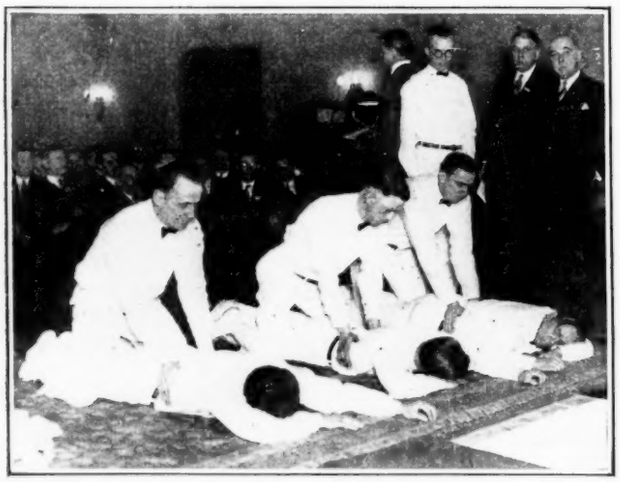
Discussion by Egbert Douglas, of Milwaukee, centered on the apportioning of fixed charges between power and heat. In this climate where the heating season lasted seven or eight months, the expense of the boiler plant was in many cases fixed almost entirely by the demand for heat, so that a proper division was essential to give correct power costs.

Turbine Testing

Some years ago the General Electric Company undertook the development of apparatus for finding the relative efficiencies of various types of nozzles and the absolute values of the losses in those nozzles. Investi-

gations using this equipment have been made continuously since that time. They have supplied a great deal of information that has been utilized wherever possible in the design of the nozzles used in steam turbines built by the company and have provided data that have been valuable in the analysis of results obtained from tests of the turbine as a whole.

A part of this development followed the type of investigation in which nozzles were tested with air, and another part took the form of the development and operation of a reaction-nozzle testing machine. Details of this latter apparatus were made the subject of a paper for the conference by G. B. Warren, and J. H. Keenan, both engineers of the General Electric Co. In the paper the authors pointed out the difficulties encountered in these reaction nozzle tests, the means of eliminating them and the methods of obtaining and developing test data. There was discussion of the underlying principles and the type of results they would indicate, and sample test curves were presented to show the close agreement between the expected and the actual data.



First aid by team of Public Service Co. of Northern Illinois

Mr. Warren outlined the substance of the paper in an informal way and was followed by Mr. Keenan who went into a little more detail on the arrangement of the test equipment, the means of eliminating difficulties and preventing errors creeping into the system.

First Aid and Power for Coal Mines

C. B. Scott, president of the National Safety Council, in a talk on "Safety and First Aid in Industrial Plants," emphasized the economic importance of keeping up the competency of the human element. As an interesting diversion having a bearing on the subject, demonstration of first aid was given by an expert seven-man team from the Public Service Company of Northern Illinois.

"Purchased Power for Coal Mines in Illinois" was a subject on which J. Paul Clayton, vice-president of the Central Illinois Public Service Co., of Springfield, gave some interesting information. He traced the early power development and the advent of central-station power in the state and gave applications for purchased power and the energy consumption for different operations. The operating costs per ton of coal hoisted for purchased power was given as 8.3c. as compared to 12c. per ton, an average figure for steam-generated power. Reasons for purchasing power and the advantages were enumerated.

Banquet Meeting

Inspection trips occupied the afternoon, and on Thursday evening there was a banquet meeting which was well attended. Charles Piez acted as toastmaster. According to Mr. Piez, "the day of the isolated plant is over; the day of the central station has come." Seven out of the eight plants of the Link-Belt Co., of the board of which he is chairman, buy their power from the electric company. "Power and machinery," he said, "are the hardworking twins that have brought prosperity to this country, the ultimate population of which will depend upon the amount of power that we can produce."

J. A. Emery, vice-president of Ford, Bacon & Davis, Inc., traced the effect of the use of power upon the progress of man from its first procurement from domesticated animals, and gave interesting statistics of the increase in its use.

Although Watt's great adaptation of steam to power was made 150 years ago and Stephenson's adaptation of steam power to traction 100 years ago, the total power per family in 1880, or within the recollection of a middle-aged man, was only about 3 rated horsepower. By 1900 this figure had only increased to 4.7 rated horsepower per family, so that all but a small part of this incomparable facility has come to us within a quarter century. This has been largely due to the development of electricity as a medium of distribution and to the rise of the internal combustion engine.

Of course, the great bulk of the present available power is used for transport, but central station and other industrial power increased from about 4,000,000 hp. in 1880 to about 45,000,000 in 1925.

The speaker predicted a considerable development in the use of tidal and wave power, referred to the attempts that had been made to produce power directly from the heat of the sun, the use of heat from the earth and the possibilities of deriving power from the atom.

We have gained in power but have saddled ourselves with complexity. Abundant power is easily accessible and applicable forms have worked wonders in chemistry and physics and who knows but what it may stretch out toward a solution of the ultimate mysteries. We must guard against a loss of the spiritual in all this accession of physical and material power. The statesman and the teacher must watch out that the engineer does not go too far ahead of them.

Mr. Piez called upon John Hunter, who served under him when he was director-general of the United States Shipping Board Emergency Fleet Corporation, and introduced him as the "shipbuilder."

Charles Keller, of the Byllesby Engineering & Management Corporation, who took an active part in the organization and activities of the Power Section of the War Industrial Board, told of the difficulties encountered in the carrying out of contracts for munitions during the war and the interruption of the social and industrial order on account of shortages of power. These conditions were ameliorated through allotment, interconnection, priorities, the putting into commission of abandoned plants and assistance in financing extensions. Organizations under the Army and Navy Munitions

Board had been effected for the maintenance of information with respect to power available and machinery for its orderly co-ordination and employment in case of another emergency.

Oil and Gas Power

The final session of the meeting on Friday morning was devoted to oil and gas power. A. A. Potter, of Purdue University was in the chair. "The Diesel Engine in the Industries," was a topic treated by Max Rotter, vice-president and engineer of the Busch-Sulzer Bros. Diesel Engine Co., of St. Louis. He discussed the developments and adaptation of the Diesel engine for supplying power to the industries and in a general way indicated the consideration that should be brought to bear when comparing this type of prime mover with other means of generation or supply.

Capacities up to 5,000 hp. gave the Diesel engine a place even in the largest industrial plants, and past operation had shown that reliance could be placed upon a single unit for power generation. The question as between purchased power, steam and the Diesel engine usually resolved itself into one of comparative power cost alone, and this cost was determined by three main conditions—the requirements, the locality and the cost of the plant. Attention was called to the high efficiency of the Diesel engine at less than rated loads and comparison made of heat losses between steam and Diesel engine plants.

Concerning the permanence of the supply of fuel oil, Mr. Rotter felt that there need not be any misgiving, as in his opinion petroleum will last as long as it is needful. When considered as a Diesel fuel, the oil must be clean, substantially free from water and for the lowest viscosity heated sufficiently so that it will flow freely, but not to the point at which it will give off vapor. Usually, this heating can be done by the jacket water. The ash content must be watched and after filtering should not exceed 0.05 per cent by weight, while a limit of 0.02 per cent is to be preferred.

Specific gravity of oil, usually measured in degrees Baumé at 60 deg. F. was little more than a general indication of the properties which may be expected, but as it had become the set commercial practice to grade fuel oils according to specific gravity, they usually must be purchased on this basis, and it would be found that fuel oils ranging between 24 and 34 deg. Baumé at 60 deg. F. were usually to be preferred. Some oils heavier than 24 deg. might be used, but fuels lighter than 34 deg. should be avoided as they generally were more expensive and had a tendency to wash off lubricants. The flash point was of importance only as it affected safety and storage and usually would be objectionable only if under 125 deg. F.

Although ordinarily a minor item of expense, the water for cooling the Diesel engine is a matter of importance. Any water suitable for boiler feed will be suitable for jacket cooling, but the reverse is not always true, as in the latter case difficulty with hard water may be avoided by keeping the final temperature below the point at which the impurities precipitate, and the water may be cooled for re-use by any of the usual means. Preferably, initial temperature should not be over 50 deg. F. and discharge temperature may range from 110 to 125 deg. for hard water or up to 150 deg. for soft water.

Labor for operation is practically of the same grade as required for a steam plant, and with an equal number of units the same number of men will be employed, except that in the Diesel plant the boiler-room operators and the coal and ash-handling crew are eliminated. Consumption of lubricating oil might be included safely at the rate of 1 gal. per 2,400 brake hp.-hr. with small engine units, down to 1 gal. per 3,000 b.hp.-hr. for large engines. Roughly, the cost of lubrication in a Diesel engine plant had been found to be about one-tenth the fuel cost in a small plant and one-twelfth in the larger plants. An equivalent steam-engine plant would consume one-half to two-thirds of this quantity and a steam turbine plant one-eighth to one-tenth.

Records carefully kept over an extended period indicated that maintenance might be figured conservatively to be $1 per 2,500 b.hp.-hr. for small engines, down to $1 per 5,000 b.hp.-hr. for large units, this being substantially the same as for equivalent steam plants, including the boilers. Other matters discussed in the paper were the method of determining charges for depreciation and obsolescence and the possibility of utilizing the heat in jacket water for heating or process work. The advantage of fuel handling was mentioned, and also the fact that underground fuel storage leaves the surface available for other uses. In conclusion, reference was made to two Diesel-engine plants, one small and one large, as typical of what had been done in this field.

Internal Combustion Engine for Railway Service

Samuel M. Vauclain, president of the Baldwin Locomotive Works, gave a thorough and most interesting review of the internal-combustion engine as applied to self-propelled and gasoline electric cars for railway service and full-powered locomotives driven by Diesel engines. The full history of the art was traced from the beginning and details given on all worth-while types developed in this country and Europe.

The rise in price of gasoline had left the field open in recent years to the heavy Diesel oil engine types. Mechanical, hydraulic and electric types of transmission were available for connecting the power to the driving mechanism. Although costly, the electric transmission was the most attractive from the railway viewpoint. All-around utility trials had shown an economy of 7.3 per cent for the steam locomotive as compared to 26.4 per cent for the Diesel-electric locomotive. Weights of the latter bear a ratio of 1 to 1.5 to that of the steam locomotive and construction costs are in the ratio of about 2 to 1. The largest Diesel electric locomotive in this country, rated at 1,000 hp. and weighing 275,000 lb., was built in 1925 by the Baldwin Locomotive Co. It was the speaker's prediction that eventually main lines would be electrified and the Diesel-electric would operate on branch lines, switchyards and industrial sidings.

A Diesel-electric, compressed-air combination was brought out in the discussion of the paper and certain inquiries made as to relative costs, running speeds, etc.

Allen F. Brewer, of The Texas Company, discussed "The Economics of Oil as a Boiler Fuel." He considered fuel oil as a specialized resource which, as the supply was limited, must be decided on the basis of priority of right, as well as economic considerations. The Navy, merchant marine and railroads in non-coal-bearing country seemed to have preference. On the other hand, fuel oil may be feasible for stationary boiler purposes within the area of the oil fields, wher-

ever tidewater delivery is possible and in the event of the possibility of obtaining delivery contracts based on periods of not less than two years. Ash elimination and labor saving made it an attractive fuel even at a somewhat higher cost per 1,000 B.t.u. than for coal, but of course the user was at the mercy of a restricted market.

If fuel oil is used, it should be fired with care not only for the sake of economy but also for the conservation of a natural resource. The speaker enumerated, as the essentials of proper firing, the right amount of preheating, cleanliness of the furnace and boiler heating surfaces, no air leaks, no oil leaks and accurate air control.

The extent to which fuel oil should be preheated depended largely upon the viscosity and gravity, but as a rule, the heavier or more viscous the oil, the higher should be its firing temperature to insure effective pumping and atomization. Too high an oil temperature might give rise to carbonization within the burner or oil line and might also cause unsteady burning owing to pulsation.

Clean furnace walls meant that the checkerwork and baffle walls were free of coke and soot and soot blowers should be used on the boiler tubes. Clean water surfaces were secured by the use of good water. Air leakage was detected by low carbon dioxide. The admission of too much excess air either intentionally when burning fuel oil or through leaks in the boiler setting was, perhaps, the most prevalent cause of reduced boiler efficiency. Oil leaks resulted in the loss of fuel and increase of fire hazards. As a general rule these fuel oil leaks showed up ultimately in the form of drippings, oozing out on the surroundings, or discoloration of the adjacent earth. As a result there should be little difficulty in determining that leakage is taking place and in tracing it to the point of fault. An effective means of correcting leaks was to make up the faulty joints anew, using a suitable joint compound, a mixture of litharge and glycerine or paper board soaked in shellac.

It was the author's opinion that specifications drawn for the purchase of fuel oil should not be too rigid. He said the main question was, Will the oil pump freely and atomize properly in the furnace, rather than the fire point of the oil, the sulphur content or the B.t.u. value? What was needed was a broader viewpoint in regard to specifications in general and a greater degree of confidence in the ability of the marketer who ,above all, should be conversant with market conditions and the best judge as to the physical characteristics of fuel oils he had to offer and their suitability for the purpose intended. In other words, the better plan was to ask for advice on oil that will give satisfaction rather than to draw specifications that would bar all but the most costly oils.

In the final paper of a most successful meeting, H. H. Clark brought out the possibilities of gas in industry. Comparisons were made of the relative efficiency of gas and electricity for light and heat. The great advance in the field was reviewed with specific reference to byproduct recovery, and the burning of the gas under boilers or within the boiler. Some of the problems of the industry were cited and reference made to the tremendous growth that had taken place. Last year the output of gas in this country had been 440 billion cubic feet.

First Midwest Power Show a Big Success

Approximately One Hundred and Seventy-five Manufacturers Represented—Attendance Much Greater Than Anticipated—Unusual Interest Shown in Equipment Representing Latest Practice in the Power Field

SUCCESS crowned the efforts of those responsible for the planning and administration of the first Midwest Power Show, which was held at the American Exposition Palace, Chicago, Jan. 26-30. The attendance was much greater than had been anticipated, and the interest shown in the various exhibits, representing in all about 175 manufacturers, attest the popularity of the show as a means of studying the various lines of power-plant equipment and the furthering of engineering progress.

Considering the fact that this was the first show of its kind to be held in Chicago, and following so short a time after the fourth annual Power Show in New York, the success that attended it is significant. Not only is Chicago situated in the center of a large industrial section, but it is ideally located geographically for an exposition of this kind, so that the Midwest Power Show bids fair to become an annual event.

The Midwest Power Conference, which was held during the same week and at which papers dealing with the trend in practice to obtain better economy and the better use of equipment and wider availability of power were presented, helped swell the attendance at the show.

The exhibits, which covered a floor space of more than 60,000 sq.ft. and comprised one of the largest exhibits ever held on one floor, covered a wide field of power-plant appliances and equipment. Practically every line of apparatus used in the power field and many of the latest developments were shown.

As would naturally be expected, the principal exhibits comprised equipment in which there has been recent active development to meet the demands of the power plant brought about by the trend in certain lines and the conditions imposed by the higher steam pressures now being adopted. Principal among these were coal pulverizing and burning equipment, water- and air-cooled furnace walls, air preheaters, motor-operated valves for high pressures and automatic combustion-control apparatus. In the field of prime movers only units of comparatively small powers were shown. These included small steam engines and turbines for driving auxiliaries and an 80-hp. two-stroke-cycle Diesel engine. A number of manufacturers showed their machines in actual operation, and where it was not possible to exhibit a commericial size of unit, a miniature or working model was substituted. These included a hydro-jet ash-handling system, drag-scraper equipment for stocking and reclaiming coal, a skip hoist

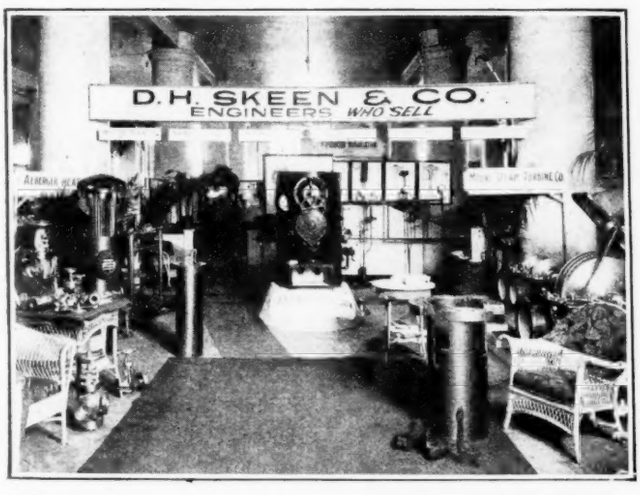
for elevating the coal to the boiler bunker, pulverized-fuel conveying and distributing equipment and many others. As an additional attraction a local coal company that operates a number of mines had a complete model of a coal tipple showing how the coal is transferred from the mine mouth to the car and graded in the process.

To present a picture of the development in the transmission of electric energy and the interconnection of hydro and steam systems that has been taking place in the States of Wisconsin, Illinois, Indiana and Kentucky and which represents an aggregate capacity of more than 1,100,000 kw., three large maps were on display, the properties of the various companies being outlined in different colors.

As Chicago is one of the important distributing centers of the country, in a number of cases a group of manufacturers were represented by one local engineering firm; in some cases the products of as many as seven manufacturers were displayed in one booth.

Some indication of the position the power show of this kind has attained from a business point of view might be gleaned from the fact that more than one hundred manufacturers who exhibited their products at New York the first week in December repeated their exhibits in Chicago. As many of these exhibits were covered in the report of that show in the Dec. 8 issue, it will be unnecessary here to repeat the description of the exhibits at length.

One of the chief items of interest at the show was that of pulverized-fuel equipment, as many as eight different manufacturers being represented. The Aëro Pulverizer Co. exhibited a 3,000 lb. per hour pulverizer equipped with a rolled steel casing, manganese steel paddles and roller bearings. The Bethlehem Steel Co. had a model of its 6-ton roller-type pulverizer in operation with a section of the casing cut away to show the constructional features. The Combustion Engineering Corp., in addition to a unit pulverizer of 4,000-lb. capacity, showed a Lopulco feeder, section of water-cooled furnace wall and air preheaters. A rather complete line of pulverized-fuel equipment was also shown by the Fuller-Lehigh Co. including a working model of the Fuller-Kinyon transport system and a miniature well-type furnace in operation. A unit pulverizer of 5,000-lb. capacity was shown by the Furnace Engineering Co. and a 5,000-lb. machine by the Riley Stoker Corp. A 1,500-lb. machine operating at about one-third normal speed with the cover removed, was shown by the Erie City Iron Works. Photographs and drawing of the "Unipulvo," which is a recent addition to the family of unit pulverizers, were shown by the Strong-Scott Co.



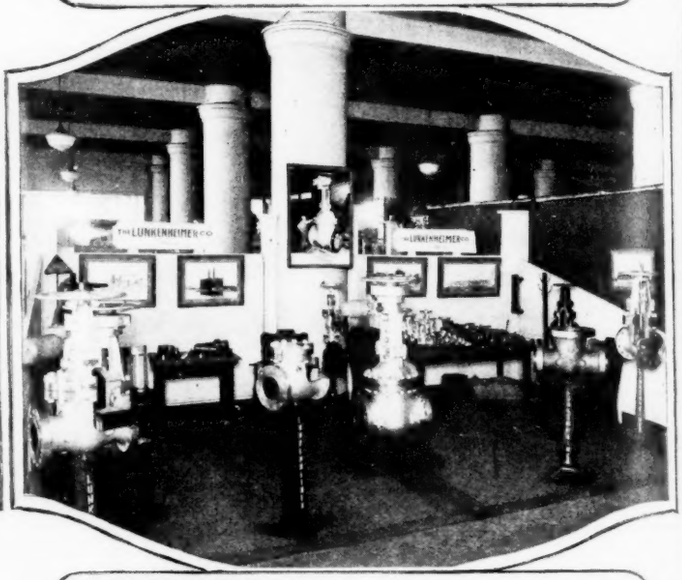
Seven manufacturers were represented at this booth

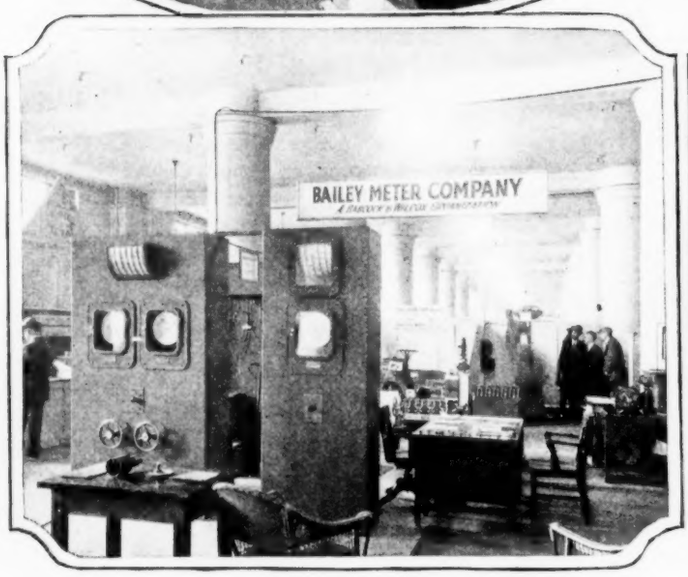
A 10,000-lb. per hour pulverized-coal feeder and meter, a description and illustration of which appeared in the Dec. 8, 1925, issue, was included in the exhibit of the Bailey Meter Co., also a section of Bailey water-cooled furnace wall and the meter control equipment for automatic boiler operation. The latter unit was shown in operation complete with instruments to show its action and method of control. Although there was no exhibit of the Babcock & Wilcox Co. as such, the signs of the Bailey Meter Co. and the Fuller-Lehigh Co. carried the announcement, "A Babcock & Wilcox organization."

One of the big exhibits of the show

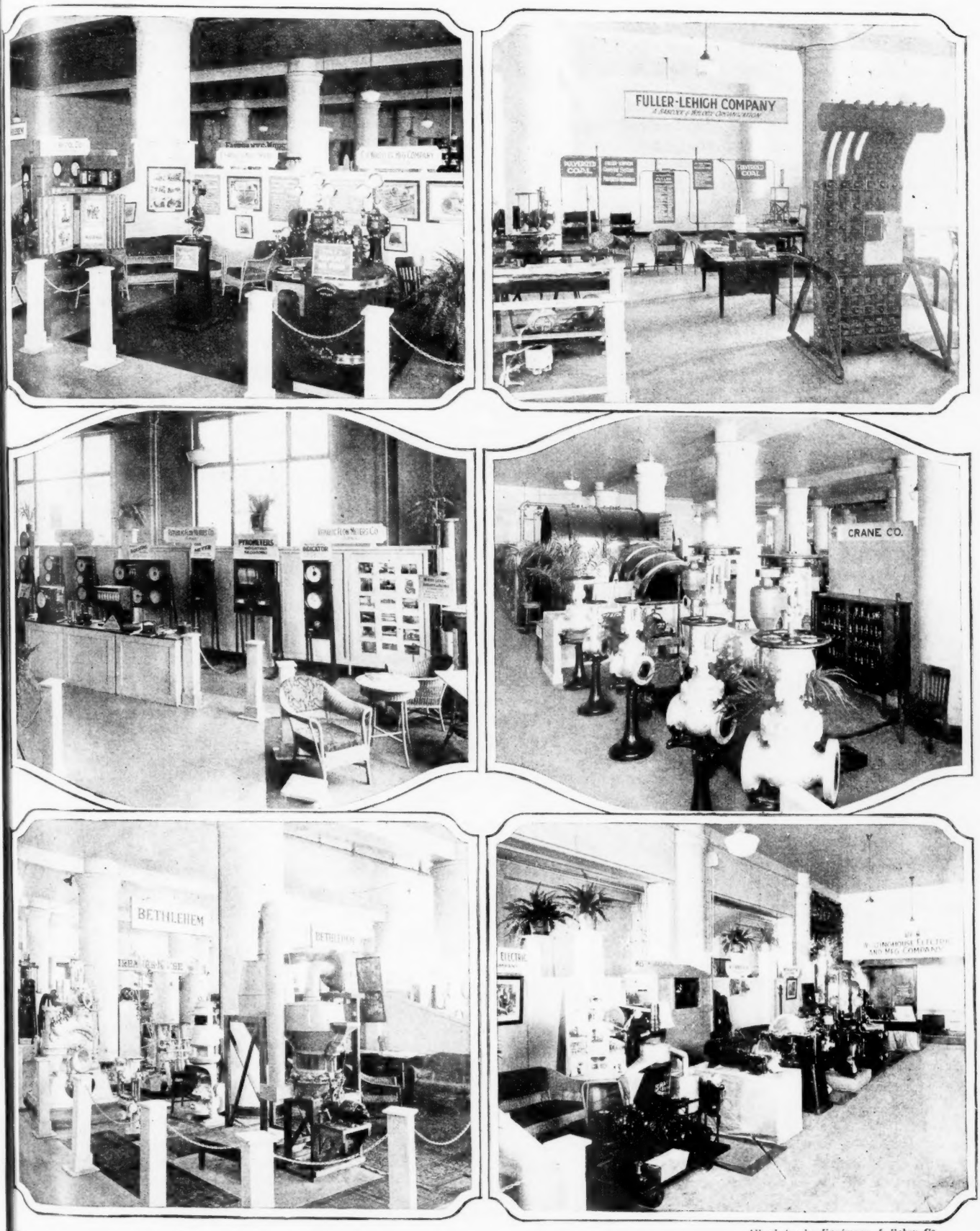
Other types of furnace walls in addition to the two already mentioned were shown by the Drake Non-Clinkering Furnace Block Co. Models of the Drake S-X air-cooled wall and two types of water-cooled furnace walls were shown. A feature of the new type of wall now being introduced by this company is the simplicity of construction. Further details of this will be given in an early issue. A model of a sectional supported furnace wall in which each section is an independent unit supported from structural steel members was shown by the M. H. Detrick Co. in addition to a section of a flat suspended furnace arch.

In the group of mechanical stokers a multiple-retort underfeed was in operation at the booth of a Detroit Stoker Co. Types of traveling-grate stokers were shown by the Riley Stoker Corp. and the Burke Engineering Co. A feature of the Burke stoker is the method of carrying each section of the grate on rollers to reduce the friction. A dutch-oven type furnace, designed for burning the cheaper grades of coal, was also shown by this company. In stokers of the hand- and power-feed types the Cokal Stoker Co. showed a 6x6-ft. unit arranged with coal hopper and feeding mechanism being driven by a ½-hp. motor through a reduction gear. A hand-operated stoker arranged with overhung ignition arch was also shown by the M. A. Hofft Co. A moving picture showing how a single tile





Some of the one hundred and seventy-five exhibits at the



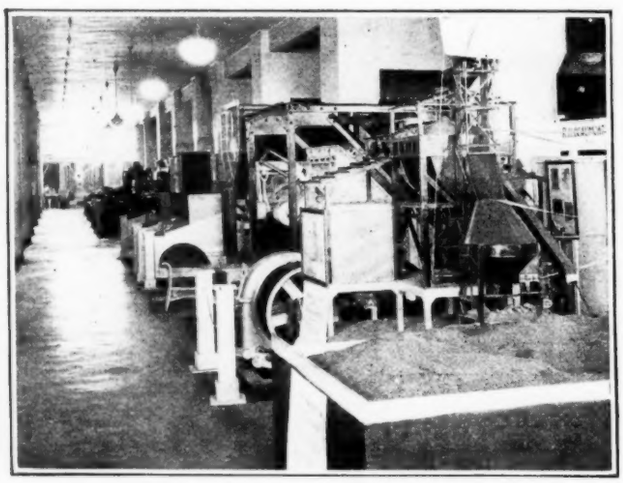
the Show, representing a wide field of power-plant equipment

All photos by Kaufmann & Fabry Co.

of the National Arch can be renewed without disturbing any of the other tile was an added attraction. A screw-feed type of underfeed stoker, known as the "Iron-Fireman," designed especially to burn screenings and for use with heating boilers of less than 2,000 sq.ft. of heating surface, was demonstrated by the Iron Fireman Corp. This stoker has a self-contained forced-draft fan driven by the motor used to drive the stoker.

A feature of the exhibit of the Allis-Chalmers Co. was the Reyrolle armor-clad switch gear, which has been used for some time in Great Britain and Europe and is now being introduced by them in this country. In this unit all the conductors, including the high-tension busbars, series and potential transformers and disconnecting switches, are completely inclosed in grounded metal casings. The construction of the switch is such that it is practically impossible for a person to make accidental contact or come within arcing distance of a line conductor. Other units in the exhibit included small steam turbines for auxiliary drive, motor-driven centrifugal pumps, application of the "Texrope" drive, and, as an added attraction, the second commercial turbo-generator set made by C. A. Parsons in 1885 was shown. The turbine is double-flow 10-hp. and is operated at 17,000 r.p.m.

The General Electric Co. had an extensive exhibit of its products, including a small steam turbine for auxiliary drive, direct- and alternating-current motors, synchronous motors, and generator air-coolers. A spectacular feature of the exhibit was a mercury arc rectifier which was in operation. Features of the rectifier



View down one of the aisles

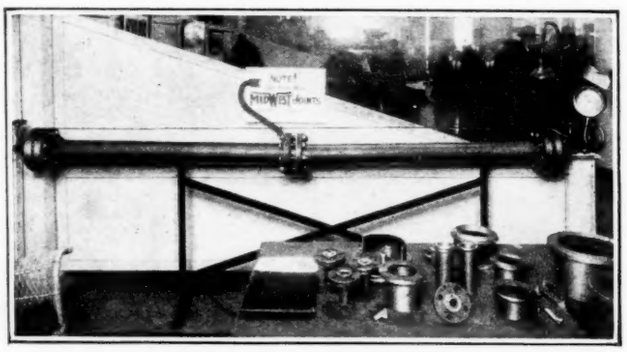
and the synchronous motor were described in the Dec. 8, 1925, issue.

Among the exhibits of the Westinghouse Co. were a two-stage air ejector with surface-type inter- and after-condenser, a 35-kw. generator turbine-driven through reduction gear, and a small turbine unit for auxiliary drive. A Sharples centrifugal oil purifier was also exhibited by this company. Types of centrifugal oil purifiers designed to meet various needs were exhibited by the De Laval Separator Co.

The outstanding prime mover at the show was an 80-hp. two-stroke-cycle solid-injection Diesel engine built by the Fairbanks-Morse Co. Small reciprocating engines suitable for driving auxiliaries and stokers were shown by the Troy Engine & Machine Co.

Fuel-oil burning and pumping apparatus were shown by the Bethlehem Shipbuilding Corp.; also a 900-gal. per min. single-stage turbine-driven feed pump to operate against 600 lb. pressure.

A feature of the show was the extensive exhibits of boiler-room instruments. The Bristol Co. exhibited its water-level gage and moving strip chart voltmeter for recording line surges. The Brown Instrument Co. showed continuous chart recorders for temperatures and



Line stretched from flange to flange showed piping need not be in alignment; 2,000 lb. pressure was maintained on this section during the show

CO_2 measurements and an illuminated dial CO_2 and flue-gas temperature indicator. A feature of the Foxboro exhibit was a differential-pressure-type liquid level gage in the indicating and recording types. The "Hays" line of instruments was exhibited by the J. W. Murphy Co. A somewhat elaborate display was that of the Republic Flow Meters Co., most of the instruments being mounted on panels as in actual installations. An interesting feature of the exhibit was the demonstration of the motor-driven CO_2 recorder.

Valves and Fittings

In the field of high-pressure valves and fittings the motor-operated unit was the chief attraction. A 16-in. high-pressure valve with motor control was shown by the Chapman Valve Co. Two motor-operated valves with an electrically operated emergency stop valve mounted between them, were shown by the Crane Co. in addition to its general line of valves and plumbing fixtures. An extensive line of valves for pressures ranging up to 900 lb. and a temperature of 750 deg. comprised the exhibit of the Lunkenheimer Co. Other companies showing motor-operated valves were the William Powell Co. and the Walworth Manufacturing Co. Types of motor units and controls designed especially for valve operation were shown by the Cutler-Hammer Co.

A forged-steel valve in sizes from ½- to 2-in. designed for pressures up to 1,200 lb., was shown for the first time by Manning, Maxwell & Moore Co. in addition to the regular line of Hancock valves and Consolidated safety valves handled by this company. High-pressure valves of the toggle-top type were shown by the Foster Engineering Co. and the Schütte & Koerting Co. Other companies exhibiting their line of valves and fittings were the Continental Valve & Equipment Co., the Everlasting Valve Co., the Hydraulic Press Manufacturing Co., Jenkins Bros. and the Reading Steel Casting Co. Lubricated plug valves were shown by the Barco Manufacturing Co. and the Merco-Norstrom Co. The latter

company featured a 16-in. plug cock for use in illuminating gas lines.

A spectacular feature of the Yarnall-Waring exhibit was a weir placed at a height of about 12 ft., over which there was a continuous flow of water amounting to about 35,000 lb. an hour. At each side of the weir a V-notch indicating, recording and integrating meter was mounted to demonstrate the weir principle of measurement. Several arrangements of the Yarway type B seatless and the double tightening blowoff valve of the direct- and gear-operated types were shown, as well as a tandem arrangement of the Yarway seatless blowoff valve of the angle and straightway types.

At the booth of the Elliott Co. a two-stage Kerr turbine for auxiliary drive was shown with separate specimens of buckets and other features, also a 500-gal. building-type deaërator, cut-away models of the Elliott-Ehrhart air ejectors, receiver separators and Liberty tube cleaners. The Wheeler Condenser & Engineering Co. showed a model of its atmospheric cooling tower, a two-stage centrifugal pump and a section of its high-pressure evaporator to show the type of coil used. The C. H. Wheeler Manufacturing Co. showed types of radojet air pumps and augmenters, and as a special feature displayed photographs of its 70,000-sq.ft. condenser now in service at the Richmond plant of the Philadelphia Electric Co., one of the two largest yet built.

In coal-handling equipment working models of a skip hoist and drag bucket were shown by the R. H. Beaumont Co., the standard winding drum and control being used to operate them. A section of an ash hopper with pivoted ash gate was also shown. A working model of a drag scraper for stocking and reclaiming coal was demonstrated by the Sauerman Bros. Models of a rotary breaker and crusher used in preparing coal for stokers or pulverizers were shown by the Pennsylvania Crusher Co., and a hydro-jet ash-handling system used to convey the ashes from the hopper below the stoker to the dump was in operation at the booth of the Allen-Sherman-Hoff Co.

Sections of the Foster extended-surface heat-absorbing elements used with radiant and convection type superheaters as well as with economizers and water walls, were exhibited by the Power Specialty Co. Two sections of "Elecso" superheater elements designed for installation in a 15,000-sq.ft. boiler were shown by the Superheater Co.

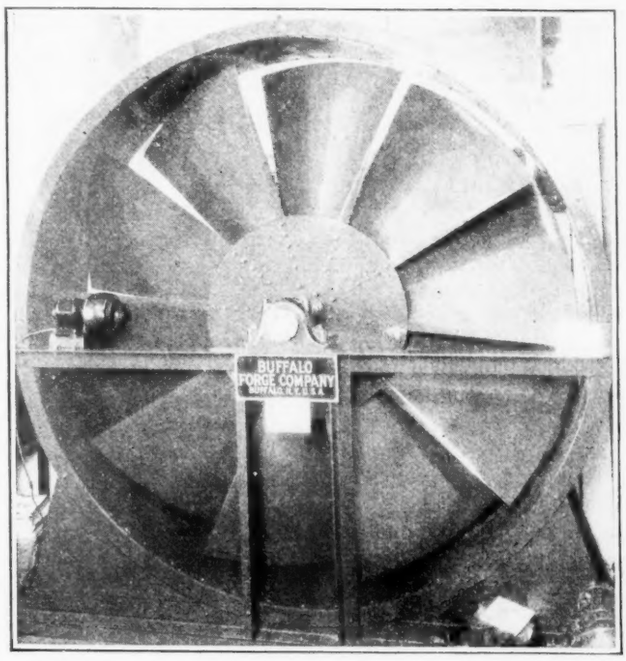
The B. F. Sturtevant Co., in addition to its standard line of power-plant equipment, showed a lead-lined economizer and air heater. The economizer was illustrated and described in the Dec. 8, 1925, issue.

Mechanical draft equipment of the forced- and induced-draft types was shown by the Buffalo Forge Co., also centrifugal feed and hotwell pumps and an air washer. As a special attraction a 96-in. disk fan mounted on roller bearings was being revolved by the impingement of air discharged from a small blower. The Clarage Fan Co. exhibited a new type blower and 4x4-in. vertical engine. The blower is equipped with two single-inlet wheels, and the blades of the wheels are ribbed and are electrically welded to the end and center rings.

In soot-blowing systems the Diamond Power Specialty Corp. showed an electrically operated system, each element being motor-driven and the main steam valve being opened and closed electrically. The Marion Machine, Foundry & Supply Co. had various types of rotary elements for return-tubular and water-tube boilers, and the Vulcan Soot Cleaner Co. showed its improved ratchet operating head and types of elements.

One of the extensive exhibits of the show was that of D. H. Skeen & Co., where a number of manufacturers' products were shown. The company exhibited its own constant-excess, back-pressure and reduced-pressure Mercon regulators and in addition samples of forged-steel welded nozzles and piping of the M. W. Kellogg Co., a Moore steam turbine and double-suction 6-in. two-stage centrifugal pump, Edward high-pressure steel valves, Ljungstrom air preheater, Alberger heaters and heat exchangers and the "Stets" water level controllers.

A number of ball and roller bearing manufacturers had typical shaft and bearing installations running to demonstrate the small amount of friction in the bearings. These included the Alhberg Bearing Co., Hyatt



Ninety-six-inch disk fan rotated by air impingement from small blower

Roller Bearing Co., Marlin-Rockwell Corp., Nice Ball Bearing Co., Norma-Hoffman Bearings Corp., S. K. F. Industries, Inc., and the Timken Roller Bearing Co. The Dodge Manufacturing Co. also exhibited a complete line of transmission machinery and a special feature showed a loose pulley equipped with a roller bearing.

To illustrate the friction set up in ball bearings with different lubricants, the Joseph Dixon Crucible Co. had a shaft running on which were mounted a number of ball bearings, the outer race of the bearings being held from revolving by a lever and spring scale similar in principle to a Prony brake. A thermometer resting in a lubricant pocket at the bottom of each bearing showed the operating temperature and the spring scale indicated the drag on the bearing. Numerous oil devices, including an oil filter, telescopic and sight-feed oilers, were shown by William W. Nugent & Co.

At the booth of the Ernest E. Lee Co. a large variety of exhibits were displayed. These included working models of the Copes feed-water regulator and the Uehling Apex CO_2 instruments. A Dings magnetic sep-

arator was energized to illustrate the action of the pulley in removing tramp iron from the coal passing over it on the belt. Other products shown were a standard type of American ring-roll coal crusher; centrifugal boiler-feed and service pumps of the Manistee Iron Works Co., several types of Bayer soot-blower heads and elements, valves and specialties of the Atwood & Morrill Co., National Valve & Manufacturing Co. and the Techno-Service Corp., a double- and guided expansion joint of the Mogul Machine Co., heat exchange apparatus of the Croll, Reynolds Engineering Co., "Dexter" valve-reseating machines and Nitrose metal preservative.

At the booth of the Wolff Co., Andale heat exchangers, Cleveland worm-gear speed reducers and Fast's flexible couplings were shown.

The Himeblau Agazin & Co. also represented a number of companies and showed two pieces of equipment of comparatively recent development, one of which was a Modine unit heater and a Wilsey-Tuthill rotary pump. The pump consists of a balanced piston-plunger rotor and the capacity of the pump is readily changed to any amount desired by simply throwing over a lever. Other products shown by this firm were Coppus blowers, Korfund cork insulating material, Sterling heating specialties, Carew-Greene separators, Witherup cork rod packing, Frank heaters and coolers and Davis traps.

In the group of automatic combustion-control apparatus at the show, the Carrick Engineering Co. demonstrated its mechanical and electric system of control, the features of which were outlined in the Dec. 8, 1925, issue. The A. W. Cash Co. showed its regular line of valves and the Craig system of control, also a hydraulically operated master regulator designed to give close regulation of the various units to which it is adaptable. A cut-away model of the A-Jacks regulator, showing the principles of construction and operation, was exhibited by the National Regulator Co.

The uses to which speed-reduction gears and variable-speed drives are adaptable is steadily increasing, and a number of these gears were exhibited. Various types to meet practically any installation requirement were shown by the Boston Gear Sales Co. The Jones Foundry & Machine Co. had cut-away models and various units in operation to demonstrate the wide ratio of speeds. A variable-speed transmission of the belt-type was shown by the Reeves Pulley Co.

At the booth of the Midwest Piping & Supply Co. a number of special-type pipe joints were shown. To demonstrate the amount to which joints of this type may be thrown out of line without leaking, a section of pipe 10 ft. long with a flanged joint in the center and carrying a pressure of 2,000 lb. was shown in a horizontal position and out of line at the joint about 1½ in. without leaking, the misalignment being shown by a line stretched from flange to flange. Other types of welded joints were shown by the Pittsburgh Piping & Equipment Co.

The value of clean steam is well known by all engineers, and considerable interest was taken in the equipment for removing the impurities and moisture from steam before leaving the boiler drum. The Andrews-Bradshaw Co. had a section of a Tracifier in operation, and purifiers of the centrifugal type were shown by the Centrifix Corp. and the Hagan Corp. The latter company also showed water-conditioning apparatus and combustion-control equipment.

At the booth of the Stannard Power Equipment Co., American Marsh steam pumps, Stickle steam traps, Reliance feed-water heaters and the Ric-Wil conduit for underground steam-line construction were exhibited.

In addition to the exhibits of refractories and high-temperature cements already mentioned in connection with other exhibits, a section of a suspended furnace arch and refractory blocks were shown by the American Arch Co. To demonstrate the holding or bonding qualities of "Adamant" firebrick cement, the Botfield Refractories Co. showed a half-section of an overhung arch made up of different sized blocks, the cement forming the only supports for the overhung section, which weighed approximately 130 lb. Other companies showing sections of arches and furnace walls as well as material for lining and repairing furnace walls were the Harbison Walker Co., Liptak Fire Brick Arch Co., Norton Co., Plibrico Jointless Firebrick Co., Quigley Furnace Specialties Co., Risher Firebrick Co. and the Walsh Fireclay Products Co.

Evidence of new development and changes in boiler design to meet the demands for higher pressures was seen in the exhibits of the various boiler manufacturers. The Casey-Hedges Boiler Co., Ladd Water-Tube Boiler Co. and the Union Iron Works had photographs and drawings on display showing the constructional features of their boilers, and the Heine Boiler Co. showed a seamless forged steel header as used in the type S Heine boiler. A section of 54-in. steam drum built for a working pressure of 425 lb. and a seamless forged-steel header were shown by the Walsh-Weider Boiler Co. The Brunswick-Kroeschell Co. exhibited parts of a boiler header to show the construction and method of attaching to the drum. A refrigerating machine was also shown.

An expansion stiffener for boiler breechings and uptakes, forced- and induced-draft air ducts were demonstrated by Connery & Co., a large section of a breeching equipped with stiffeners being shown.

In the field of steam traps several types were shown. A glass model of the Armstrong bucket trap, which is built for pressures up to 400 lb., was in operation, also a model of the Eclipse trap of the Illinois Engineering Co. Other companies exhibiting steam traps, as well as temperature regulators and other accessories, were the Boyleston Steam Specialty Co. and the Sarco Co. Specialties of various types were included in the exhibits of the G. M. Davis Regulator Co., Fisher Governor Co., Power Regulator Co., S. C. Regulator Co. and the Wright-Austin Co.

Hot and cold process water softeners were demonstrated by the Graver Corp., and mixers and proportioners for dry and wet chemicals were shown by the International Filter Co. and the Power Plant Specialty Co. In addition to meters of various types already referred to, meters of the venturi type for indicating, recording and integrating rates of flow of water were shown by the Builders Iron Foundry and the Simplex Valve & Meter Co.

In the list of tools for use in the power-plant field, a motor-driven shear known as "Unishear" was demonstrated at the booth of the Maplewood Machinery Co. This machine is designed to cut any thickness of stock up to No. 14 gage at a speed around 15 ft. per minute.

A complete valve-reseating tool suitable for reseating globe valves in the flat- and tapered-seat types in sizes from ¾- to 3-in. was demonstrated by the M. B. Skinner Co. Motor-driven pipe threading and cutting machines with self-centering vise and dies, were in operation at the booth of the Curtis & Curtis Co.

A Scientific Attack On Scale and Corrosion

NO ONE who has attempted to follow the complexities of the feed-water problem or reconcile the divergent opinions expressed by various experts in this tantalizing field can fail to appreciate the importance of the research carried on for the last four years by the Bureau of Mines under the guidance of R. E. Hall.

It is not that Dr. Hall's many papers on this work leave nothing to be desired in the method of presentation. His earlier papers, in particular, while well calculated to meet the needs of physical chemists, left the average engineer feeling that here at last was some really important information on boiler water, if he could only grasp what it was all about. This may perhaps be excused on the basis that the established practice of scientists calls only for completeness and accuracy in the publication of research results. But popular treatment must follow if the principles discovered are to be widely applied, and some of Dr. Hall's later expositions seem aimed in that direction with a fair degree of success. This applies particularly to the excellent paper delivered before the recent Midwest Power Conference in Chicago. An abstract, covering the essential points, appeared in the February 2 issue of *Power*.

Stripped of the language of physical chemistry, the fundamentals of boiler-water conditioning, as developed by Dr. Hall, are seen to be relatively few and easy to apply under practical operating conditions.

The first principle is that it is possible to maintain the various constituents of the boiler water (in the boiler) in such proportions that precipitation will form as a loose sludge, easily removed by blowing down or continuous filtration, rather than as adherent scale.

In the application of this principle tests are made directly on the boiler water with simplified apparatus adapted to boiler-room use. The first test is for sulphate concentration. This concentration depends on the amount of sulphate in the boiler water and on the percentage of blowdown. For any given boiler pressure and concentration of sulphate Dr. Hall's formulas and constants show the minimum concentration of carbonate that must be maintained (ordinarily, by the addition of soda ash) to prevent the formation of adherent scale. The actual carbonate concentration in the boiler water is measured by an apparatus of simple construction.

Steam pressures above two hundred and fifty pounds add certain complications due to the breaking down of sodium carbonate (soda ash) into sodium hydroxide. This breaking down, which is more rapid at higher pressures and also at higher ratings, has two undesirable effects—it increases the amount of soda ash required and also leads, at high pressures, to an objectionable concentration of sodium hydroxide. All trouble of this sort in high-pressure boilers may be eliminated, according to Dr. Hall, by the simple expedient of substituting sodium phosphate for soda ash. Unfortunately, sodium phosphate costs several times as much as soda ash, but this objection is generally less important with high-pressure boilers because they are ordinarily fed with relatively pure water requiring but a small amount of treating chemical.

The foregoing is not by any means the whole story—the complete solution for any particular installation requires a study of the best method of removing precipitation from the boiler, of removing impure water entrained in the steam, of avoiding undue amounts of air, CO_2 and other non-condensable gases in the steam and of preventing corrosion in feed lines, economizers, etc. All these matters have been considered in this research with apparent solutions for most cases that occur in practice.

This is a fine example of the service rendered to industry by intensive scientific research. Many other matters of vital interest to those who design and operate power plants would benefit from an equally exhaustive study.

The Comparison of Performance Data

ENGINEERS are constantly confronted with the necessity of making decisions as to equipment and methods on the basis of comparisons of test data or of operating experience. If perfect comparisons could be made, life would be easy, but in proportion as one's responsibilities increase, so does exact comparison become more difficult. The carpenter has no difficulty in choosing between a plank that is too short and one that is long enough to span a gap; but the engineer who chooses a bridge to span a river must consider more carefully.

In the power field one is beset with a variety of equipment and methods limited only by the ingenuity of man, and the claims and counterclaims of rival interests are often more confusing than helpful.

It might seem that it would be easy to determine which is the more economical of two existing plants or pieces of plant equipment, and to select one or the other to meet the needs of a third enterprise. Not so. Construction costs vary with time and place. Wage rates vary with place, and the effectiveness of the worker is a function of the organization of which he is a part. Fuel varies in cost and heat value and in the ease of handling and burning. Load factors vary. Design and operating methods affect maintenance costs. Hardly anything stands fast.

But, it is alleged, in the field of purely technical economy, at least, exact comparison is easy. Would that it were! The difficulties are great and the skill of special pleaders is not applied to making the path smoother. How often do we see test curves plotted

against a quantity that makes one scheme appear superior to another, when we know that the margin is not so great, or even that the reverse is true.

The use of the coal rate and the steam rate is fast declining, and the heat rate is increasingly recognized as the only basis for beginning a comparison of steam generating or using equipment, but this is indeed only a beginning. Plants are often laid out on the assumption of high load factor—"base load" operation—despite the fact that it has been demonstrated that such conditions are astonishingly short-lived. Fixed charges are often overlooked or underestimated. Optimistic assumptions are pleasant to hold, but how bitter is the subsequent disillusionment!

Against these dangers every engineer must set his face, with a strong determination to study intensely, to think clearly, and keep himself free of all prejudice. Good engineering lies not in change for its own sake, but rather in the skillful adaptation of means, old or new, to the appropriate accomplishment of the special task in hand. Superficial copying of successful work may be fatal. Each must know his own needs in the fullest detail and must measure every proposal by the yardstick of his peculiar requirements, thinking not at all of the opinion of others, but solely of a well-balanced assembly suitable to the work to be done.

Power Factor Correction an Economic Problem

INTERWOVEN throughout the whole fabric of alternating-current power generation, transmission, distribution and utilization, is the problem of maintaining a high power factor in the system. This problem is practically as old as the alternating-current system and each year is taking on added importance as the sizes of power systems increase and the number of inductive devices served becomes larger. Although the chief cause of low lagging power factor is the inductive power utilization equipment, such as induction motors, certain types of furnaces and welding equipment on the system, the effects are felt all the way back to the coal pile in the power house. These effects are increased investment to supply a given load, increased losses in the system per unit of power delivered, impaired voltage regulation or greater requirements for automatic voltage regulation, and increased complications in operation.

As to increased costs of power systems due to low power factor, in a recent report of the National Electric Light Association's Electrical Apparatus Committee, on "Power Factor Improvement," the statement is made regarding a study carried out by the committee on a large power system: "On a system in which the investment in electrical equipment is fifty million dollars, the improvement in power factor from seventy-five to ninety per cent increases the capacity of the system to carry load by an amount which at a proportional cost would exceed eight million dollars." Among the large items of cost in power generation are fixed charges, and these are on the increase, while most of the other charges are practically constant or are decreasing. The statement quoted shows the possibility of keeping down the capital charges by maintaining the power factor of the load high on the system, but the improvements in power factor must be made at the load to obtain the maximum benefit.

The foregoing figures do not include the increased cost of the utilization equipment to the consumer, due to overmotoring and increased investment necessary in the industrial distributing system to supply the load. All these costs must be paid by the consumer. If equipment costs eight million dollars more to supply the load at seventy-five than at ninety per cent power factor and seven per cent is paid on this investment, it adds five hundred and sixty thousand dollars a year to the cost of generating and distributing the power to the consumer, which he must expect to pay. This does not include the increased losses in the system, which must also be included in the consumer's bill.

Improvement of power factor by the consumer is not in all cases a simple problem, but it is much easier today than a few years ago. High power factor motors can now be obtained in small sizes. Slow-speed synchronous motors are available in comparatively small sizes, and improvements in design have greatly extended the field of application of this type of machine. An intelligent use of such motors in the power equipment of most industrial plants, possesses economic possibilities that are attractive, especially if a premium is paid for high power factor loads on the system. This problem is not a one-sided one; both the power company and the consumer have a vital interest, since it reduces costs, improves service and simplifies operation, and both should co-operate to this end.

The expression, "The power load exceeds the heating load," is frequently made for the sake of shortness or simplicity. Strictly speaking, of course, the two cannot be compared. Like hours and quarts they are two entirely different things. The expression as used means that with the given engines under given steam conditions the exhaust exceeds the entire heating and process demand. With no change in the power or heating-steam requirements the "power load" can be made less than the "heating load" by the simple expedient of using less steam to produce a kilowatt-hour. This may be accomplished by using a more efficient engine, by raising the steam pressure and superheat or by lowering the exhaust pressure.

Too much attention given to equipment is sometimes as bad as neglect and results in just as unsatisfactory service. There are machines that are unsuited for their work that must be given a lot of attention to keep them going, but good apparatus put in proper shape should run for long periods with little attention other than the daily or weekly inspection, which should be made as thorough as possible without too much dismantling of parts. Daily adjustment of controller contacts or the opening of motor bearings to see if the oil rings are moving may easily defeat the purpose of the effort. Moderation is good in most everything, and maintenance work is no exception.

An unforeseen hazard has developed in connection with the use of pulverized coal, namely, carbon monoxide poisoning. In one instance four men were overcome, two fatally, when they entered a storage bin containing pulverized coal. While such accidents should not be permitted to influence one against the process, they should nevertheless serve to emphasize the necessity of providing all possible safeguards.

Practical Ideas From Practical Men

Improving the Operation of the Plant Without Spending Any Money

An engineer should always go over his plant to learn if there are any chances of improving operation of the equipment or reducing costs in a way that will not call for any outlay of capital at the start, before suggesting radical changes to the man higher up that may involve the expenditure of several thousand dollars. Not that many old plants will not be benefited by the expenditure of a few hundred or thousand dollars on improvements, but the fact that he has been able to effect a saving at no initial expense gives a man a standing with his employer that will go far toward getting a favorable decision on some more elaborate plans later on that call for the co-operation of the man who controls the financial policies of the firm.

This is true especially in the case of the engineer taking charge of a strange plant, who has not yet won the confidence of the management. He does not have to do anything so remarkable as saving 25 per cent of the coal bill right at the start, but even a small saving made by the process of planning the operating routine more intelligently and securing the co-operation of the operating crew, will count heavily in his favor.

Savings can be made in some plants in ways that are remarkably simple, and I have sometimes wondered how these methods escaped the notice of my predecessor. In practically every plant I have had charge of, the operating schedule was 24 hours a day, which makes uninterrupted operation paramount to other considerations. Any saving that is made must be done in such a way that the steady supply of power is not jeopardized, for no plant manager will risk shutdowns for a small fuel saving.

In one plant fluctuating steam pressure caused considerable fuel loss until it was firmly impressed upon the firemen that they had more work to do after the steam dropped than if they had maintained it at the highest point. Our load was such that a drop of only 10 lb. would cause the head-end valve on the Corliss engine to hold open full stroke. At the full boiler pressure of 125 lb. the cutoff was about $\frac{3}{4}$ stroke, and when the drop in pressure occurred, the head-end valve would hold open full stroke for two revolutions of the engine, and then the governor would rise high enough to make the valve trip for the next two revolutions, after which the valve would again hang up for two revolutions more. The engine had only one eccentric, and it was not possible to retard the eccentric any, as that would reduce the compression and we were running with the least possible compression that would give a quiet-running engine. Since the head-end valve took steam full stroke half the time at 115 lb. pressure, there was practically no expansion and the steam flow was increased substantially as the terminal pressure was 95 lb. At $\frac{3}{4}$ cutoff the terminal pressure was 23 lb.

I explained to the firemen that as a cubic foot of steam weighed 0.09 lb. at 23 lb. gage and 0.247 lb. at 95 lb. pressure, the engine exhausted over $2\frac{1}{2}$ times as much steam when it did not cut off as it would under proper steam conditions.

"But you're getting $2\frac{1}{2}$ times as much power, so what do you lose?" remarked the fireman on the day shift. "Now I'll show you your mistake," I told him. "The indicator diagrams show 68 lb. mean effective pressure at $\frac{3}{4}$ cutoff and about 100 lb. at full stroke with no expansion. So in order to get about 47 per cent more power, we have to use 150 per cent more steam, since the power developed is in proportion to the m.e.p. when the speed and engine cylinder size are necessarily the same."

The firemen took their newly acquired knowledge seriously, and our fuel consumption for the following month was 17 tons less than usual, a saving of about $2\frac{1}{2}$ per cent of the total. As the engine used only half of the total steam flow, this was equivalent to a reduction of 5 per cent of the fuel required by the engine. As the cost per ton was $7, this would amount to $119 a month, or nearly the wages of one fireman. The feed temperature was irregular owing to admitting too much makeup to the heater, and this makeup was supplied through a 2-in. line and was controlled by hand by throttling the supply valve. A $\frac{3}{4}$-in. bypass was put around this valve and the 2-in. valve kept closed. This prevented the heater from overflowing and maintained the temperature constantly at 210 deg. F., whereas it had formerly varied all the way from 170 to 210 deg. The water level in the heater rose more slowly than formerly, the supply through the small line being about equal to the requirements, while in case of an extreme drop in the boiler-water level the firemen had instructions to open the 2-in. valve long enough to eliminate any danger of low water.

Certain parts of the plant including the office were heated by the indirect system, coils being placed in the basement and outside air conducted through flues over the coils and into the rooms to be heated. In severe weather it was impossible to heat the office even though live steam at 40 lb. pressure was used in these coils. Complaints came continually from the office that the place was very uncomfortable until about 10 a.m., at which time the temperature started to go up. Upon investigating this matter, I found that the heating surface was more than ample for the purpose and looked elsewhere for the trouble. I found the office was kept locked all night and the office force came to work at 8 a.m. and the doors were opened every few minutes during the day. I reasoned that the heat began to come at 10 a.m. for the simple reason that the constant opening of the doors, starting soon after 8 o'clock, caused a circulation of air, the foul air leaving by the open door and fresh warm air entering to take its place. I gave orders for the night watchman to see that all transoms over the doors were left open all night to allow air circulation.

Owing to the trouble they had experienced, the superintendent had ordered steam to be left on the coils all

night, and with the transoms open the office was heated to 79 deg. The following morning when the office help arrived, I was asked to reduce the pressure as it was too warm. The following night the steam was shut off the coils at 5 p.m. as there was no one in the office all night. At 6 the next morning the steam was turned on, and with the transoms open the office was warm by 8 o'clock.

The vacuum pump running at top speed was not able to maintain over 5 in. of vacuum in the return line, resulting in trouble in heating some coils located at the farthest point from the engine room. Looking into this, I found several high-pressure traps were discharging into the return line to the vacuum pump, which raised the temperature considerably and put extra duty on the pump. After reconnecting these traps to discharge directly to the heater, the vacuum was carried at 10 in. and the circulation in the distant coils greatly improved. Many plants contain minor difficulties of this sort, and if the engineer exercises his powers of observation, he can find many more ways of improving the plant at slight cost. J. A. MADSEN.

Chicopee, Mass.

Pipe Bending Pointers

The main things to guard against when bending pipes in the power plant are that they do not get deformed or bruised and that they do not crack. It is also desirable for the engineer to have control over the work in order to bend the pipe correctly just where required.

To prevent a pipe from being deformed during bending, it is usual to fill it with either dry sand, rosin, rosin and pitch mixed, lead, or coiled-wire springs, according to the metal being worked. Iron and steel pipes, owing to their great rigidity when cold, are usually bent when red hot, and a good filling or loading material is thoroughly dried sand well tamped or rammed down and the ends plugged. The pipes are then made red hot at the place to be bent, held either in the bench vise or suitable appliances (such as round pins or in a bending block fixed in the floor) and pulled round to the bend or curve required, water being poured on the outside of the bend to prevent excessive stretching and consequent giving of the core and the pipe wall. Long heats are not satisfactory excepting for long easy curves, and the sharper the bend the shorter the heat should be. When bending butt-welded pipe, it is best to have the seam at the side of the bend. This practice is based on the assumption that in making a bend, the neutral axis is midway between the inner and outer curves, and therefore this part of the pipe is not subjected to extension or compression while bending.

Copper pipes up to and including ¾-in. bore can be bent without annealing or loading, but in the case of larger sizes it is better to anneal and load with suitable filling material. The process of annealing copper pipes differs in practice in different plants. The customary method in our plant is to heat them to a dull red color (650 to 700 deg. C.) at the portion to be bent and cool by quenching in water. It is our practice to purchase copper pipes in the hard or semi-hard state in order to prevent them from becoming distorted in handling.

When the pipe is cold after annealing, fill with rosin or pitch, or rosin and pitch in equal parts. Lead should not be used for loading, owing to its ill effect on copper. In practice it is found that it can never be absolutely cleared from the interior of the pipe, and during subsequent heatings for annealing and other purposes the lead residue eats its way into the copper. Seamless copper pipes are generally used, but should copper pipes with brazed seams be used, care should be taken that the seam is kept on the side, for the same reason as previously mentioned for butt-welded pipes.

The bending of copper pipes up to about 4 in. can be done by leverage or pressure, using lead blocks with a hole or holes in them for the insertion of the pipes. A slight curvature should first be given, then, changing the place of contact of pipe and fulcrum, a further curvature, and so on. Rosin or pitch, as loading materials, leave behind a thin adherent film after being melted out of a pipe. This should not be forgotten when choice of a loading material has to be made. In an emergency a copper pipe can be loaded with sand or even water. The reason why sand and water should be used only in an emergency, is that the plugging at one of the pipe ends often gives way in the bending process.

To remove a snugly fitting coil spring after the pipe is bent, fasten one end of the spring to a lathe spindle so that it can be rotated in a direction that will cause it to be wound to a smaller outside diameter. This winding will reduce the size of the outside diameter of the spring so that it can be readily removed from the piping. The proper gage and temper of wire to employ depends on the diameter and wall thickness of the pipe. The spring should be well lubricated before attempting to remove it. E. ANDREWS.

Manchester, England.

Getting an Alternator Back into Service Under Difficulties

I sometimes think that the present crop of young electrical troublemen do not have the difficulties the older ones were up against. There are service and repair shops in many places, and nearly every town has dealers handling supplies, insulating tape, varnishes, wire, etc. Things were far different not so many years ago, and the older men were trained in a hard school. An instance comes to mind that illustrates how well they learned how to make the most of meager facilities.

One of the "old timers" was sent out to help get a disabled generator into service. An engine-driven alternator had failed and a section of a large town was without power. There were no coils in stock, no bar copper of the proper size was available and some of the old coils were so badly burned that they could not be insulated and used again. This particular man was very resourceful and he was sent in the hope that he could make repairs that would last until the new coils could be delivered. He reported on the job at 3 p.m., took stock of the situation and got busy immediately.

The first call was at the local roundhouse, where he secured a length of locomotive staybolt copper. Then he went to a blacksmith to get this hammered and filed into the proper dimensions. Meanwhile a careful search located some insulating paint but no insulating tape. However, silk braid and cotton braid were purchased at a dry goods store. At bedtime several bars had been formed, insulated with braid soaked in the insulating paint and were baking over the boiler breeching. Early the next morning the coils were put in place and secured with maple wedges that had been worked out by hand. The machine was back in service and carrying load by noon. N. L. REA.

Schenectady, N. Y.

Comments from Readers

Grooves in Engine Bearings

In the Jan. 5 issue, W. O. C. asks whether engine bearings should have oil grooves cut in the babbitt or brass. Assuming that he means babbitt-lined bearings, how could the grooves be cut elsewhere than in the babbitt? And if he had in mind a bronze bearing, there would be no babbitt to groove. It is probable that he had in mind something other than that indicated by the question. But in any case a few other hints besides those contained in the answer may be welcome to him as well as to other readers.

There is a tendency among a good many mechanics to cut a lot of grooves in a bearing on the assumption that the more grooves there are, the more lubrication the bearing gets and the less likely it is to heat. Then there seems to be a tendency among other mechanics with an artistic temperament, to cut the grooves in fanciful designs. Grooving should be done with the utmost economy because, at its best, a groove is a necessary evil. Every groove cut in a bearing means so much less surface area and weakens the bearing to that extent. The edges should be rounded off, otherwise the sharp edges are likely to wipe off the oil and cause the bearing to heat. After a period of use it is well to examine the bearing to see whether the wear on the babbitt has again sharpened the edges of the grooves or closed them. In sectional bearings the inside edges should be grooved away where the sections meet.

Brooklyn, N. Y. A. HOYT LEVY,
United American Metals Corp.

Complete Record of Operating Costs Necessary for Economical Operation

The article in the Dec. 22, 1925, issue, entitled "Office-Building Plant Saves by Studying Costs," by William R. Goodwin, gives a good example of the value to any "isolated plant" of having a complete record of operating costs which makes it possible to determine the most economical method of operation.

Often in the "isolated plant" it is found that the owner does not know and has no way of finding the cost of making power or of determining whether it is cheaper to buy power. Often there are not sufficient instruments to enable the operator to keep complete records, and therefore he does not keep any. The records shown in this article do not require expensive or complicated instruments and yet they show all the data necessary to determine the operating costs.

It is unfortunate that, in comparing the costs of generated and purchased power, only the operating costs were shown, as this gives an apparent saving considerably larger than the real saving. The use of purchased power requires the installation of two motor-generator sets with necessary switchboards and wiring. To supply hot water when the boilers were shut down required the installation of a gas water heater. The real cost of operating with purchased power should include the charges for interest, depreciation, taxes and insurance on these added investments.

If it is assumed, for illustration, that the total of these added investments was $5,000 and that the total annual charges for interest, depreciation, taxes and insurance are 15 per cent, or $750, the saving shown, $3,011, should be reduced to $2,261.

I have recently had occasion to analyze the power costs for several small industrial plants that were considering the installation of generating equipment to replace purchased power. It was found that the annual charges on the investment required would in some cases equal, if not exceed the operating costs, which shows the importance of including them in any comparison of power costs. WILLIAM W. GAYLORD.

New Haven, Conn.

Soap and Water for Cleaning Air-Compressor Cylinders

While reading the article on "Soap and Water for Cleaning Cylinders of Air Compressors" in the Dec. 8, 1925, issue, the thought came to me of the story of the little boy, who, after being spanked by his father, asked the latter if his own father used to spank him when he was a little boy. When told that he did, the boy wanted to know who started the blamed thing in the first place. So with the old tale of using soap and water in air-compressor cylinders to soften the carbon. We would like to ask who started it in the first place.

Mr. Pascoe's experience along this line corresponds very much with mine in trying the soap and water treatment in air-compressor cylinders to soften and remove carbon and burnt oil.

When I took charge of the power plant that I am operating, I had not had much experience with large compressors. My experience had been confined to small compressors for pumping pressure into small gas-engine starting tanks. This plant has five large air compressors, one of 2,500 cu.ft. capacity direct-connected to a 500-hp. gas engine. The other four are of 1,200 cu.ft. capacity and motor-driven. Coming under my charge were two assistant operators—one an electrical man and the other a former millwright who had had a number of years' experience with portable air compressors. He was the first to suggest the soap treatment to me.

The large compressor was equipped with a poor oiling system, consisting of a large oil reservoir mounted above the inter-cooler and small pipes leading to the different oiling points and controlled by ordinary valves. The compressor was equipped with rocker-type inlet valves which were badly worn and required an excessive amount of oil to keep them from running dry and rubbing. This oversupply of oil made a great deal of carbon and burnt-oil accumulation on the valves. The compressor was regularly subjected to large doses of soap and water, the compressor operator stating that he had used it on all his machines and that it was great stuff.

Soft soap and hot water were mixed up in a barrel,

and on soap day the large compressor was slowly fed a dose of a barrelful. But in spite of this treatment the valves had to be taken out once a year or oftener and large quantities of carbon scraped off them. Three of the motor-driven compressors are of the feather-valve type. We repeatedly tried the soap treatment on these, although they accumulated very little carbon, as the oiling system on them could be finely controlled and little oil was required. I never found that the soap treatment had any effect on the carbon deposit, so in recent years it has been abandoned. The large compressor was later equipped with an automatic oil pump, and this change eliminated a large amount of the trouble from burnt oil. We find that the most satisfactory way is to remove the valve cages periodically and replace them with another set. The removed valves are cleaned and made ready to replace the set in the next machine.

We have found that a satisfactory way of cleaning the carbon from the cylinder heads and on the ends of the pistons is to put the valve covers on the bottom ports after the valves have been removed and move the piston up to about an inch from the cylinder head and then burn out the carbon with oxygen in the same way that carbon is removed from gas-engine cylinders.

We did find, however, that when a dose of soap and water was run through an air compressor it aided in lubricating the air guns and would make them work more freely, but too much soap made them slippery and hard to handle.

L. M. JOHNSON.

Sewickley, Pa.

Heating Feed Water with Live Steam

Some time ago I was asked by an engineer if a higher temperature of feed water would not increase the economy of fuel in the production of steam, and it occurred to me that some points in my reply to this question, which follows, might interest other readers.

Your assumption regarding the higher coal cost, per 1,000 lb. of steam, when the laundry is shut down, is correct, but at the same time, it may mislead.

I will agree that it is a good idea to heat the boiler feed water to a higher temperature, as this will lessen the expansion strains on the boilers.

I cannot see that the use of live steam for heating the boiler feed water will in any manner change the final economy results.

To illustrate, let us assume that 16,000 lb. of steam is produced for each ton of coal used, as you are now operating. Then if we added, say, a closed type of feed-water heater, and by heating the feed water with live steam from the boiler, we could produce 17,000 lb. of steam per ton of coal and of this 17,000 lb. of steam produced 1,000 lb. is used to heat the feed water.

From this you will see that you would have only the 16,000 lb. of steam to use for heating the building and for other purposes, such as steam for the kitchen, laundry, and heating water for tubs and showers.

In plants where a considerable amount of exhaust steam from pumps or engines is discharged to the atmosphere, therein would lie an opportunity to use the waste exhaust steam to heat the feed water to a higher temperature than now exists, and thus effect a real, tangible fuel economy.

The old adage of making two blades of grass grow where only one grew before, is all right for grass, but it does not apply to the producing of two pounds of steam where only one pound was previously produced, if the extra pound is immediately turned into a feed-water heater.

The extra amount of steam will, of course, register on the steam-flow meter, and for this reason would show an apparent, but not an actual, lower fuel cost.

Chicago, Ill. JAMES B. LUND.

Are Welded Pressure Tanks Safe?

In the editorial entitled "Are Welded Pressure Tanks Safe?" in the Nov. 10, 1925, issue you invite discussion. My experience, while it may not add to the technical knowldge of the subject, may prove interesting.

Some years ago I was operating a portable gasoline-engine-driven air compressor with a receiver about 15 in. by 6 ft. This was equipped with a 2-in. safety valve set at 125 lb. On one occasion, when the air started freezing at the exhaust of the air hammers, I shut down on the water circulation on the compressor, which was the usual practice. After several hours of operation there was a roar at the compressor, and the safety valve blew a torch of blue flame and smoke of an intensity comparable to a cutting torch, but with a flame about four feet long. Before I could run some fifty feet to reach the switch of the machine, the top of the safety valve had melted off and blown up.

It is obvious what occurred. The tank had become partly filled with oil, and the temperature had reached the flash point of the oil, causing combustion in the tank. In my opinion, if the safety valve had not been so large in proportion to the volume of the tank, enough pressure could easily have accumulated to cause a serious wreck.

The receiver was equipped with a small test cock, but this was behind the flywheels of the engine and could not be reached when the compressor was operating. The cock was opened every other day before starting, and a few drops of liquid was all that ever came out. Evidently, this was only such oil as had filtered down through a cake of dust that had collected in the bottom of the receiver.

Possibly the condition was made worse by the fact that kerosene was used to clean the spool of the unloader. This may have diluted the compressor oil.

In my inspection work I have found a number of places where air-receiver conditions were bad. The most serious hazards are found where a garage owner has belted a compressor to a lineshaft and connected the compressor to a receiver consisting of a 30-gal. galvanized range boiler, with no safety valve, no oil drain, no unloader, no belt shifter or loose pulley on the compressor. As long as the lineshaft runs, the receiver continues to build up pressure. Fortunately, the owner has no occasion to run the shafting for long periods, but if he had, it is somewhat of a question whether the tank would let go before the compressor belt slipped off the pulley.

It is my personal opinion that some otherwise unexplainable receiver explosions are caused by the accumulation of volatile liquids or combustible gases in the receiver. This could happen, for example, if someone had been washing the machine parts with kerosene or similar liquid and had dumped the remaining liquid in the vicinity of the compressor intake. If, then, the air-discharge temperature rises sufficiently, excessive pressure in the receiver will build up almost instantly, or at least much more rapidly than the usual type of relief appliance can care for it.

This suggests to my mind that in large installations it would be desirable to design and equip the receiver with a large-sized vent ending in a T-fitting, so that the reaction on the escaping gas would be balanced. The entrance to this T should be closed by a rupture disk of a closely figured breaking strength. This might be accomplished by milling a depression in the disk in the form of a cross. The disk would then break in the same manner as the head of a tomato can when opened with two cuts of a hatchet. The disk should be figured to break at twice the allowable pressure on the vessel. If the vessel was designed with a factor of safety of five, the breaking disk would open well below the elastic limit on the steel.

While laboratory tests can be made of carefully made welded joints which show a high efficiency on the test stand, I believe it would be a grave mistake to give official approval to welded joints on pressure vessels carrying elastic substances. No doubt the people interested in the sale of welding equipment have excellent mechanics who are not only thoroughly trained in the art, but who are also instructed in the necessary technical fundamentals. They can no doubt do a welding job that will compare favorably with the best riveted work. It is a different proposition, however, to produce such work commercially in competition with other producers. The tendency is toward low cost in production and not toward high quality. The worker is likely to become careless and turn out work which, while it may look nearly the same and may test to tightness under hydrostatic pressure, will still have a joint efficiency of only a fraction of that turned out under laboratory conditions by skilled mechanics of concerns interested in the sale of welding equipment or supplies. Often the necessity for turning out a job in the absence of skilled and reliable men may lead to the substitution of men of less ability, and inferior work is the result and the user is placed in a danger which he has no way of foreseeing or preventing.

A difficulty in inspecting a welded joint is that the exposed edges of the plate are usually smeared over or the metal is dragged, so that it is impossible to ascertain the original thickness of the metal and to judge how much if any deterioration has taken place. The owner usually objects to having the plates drilled for determining its thickness.

Also, in a welded job any inequalities of curvature that may be in the ends of the sheet after rolling are not drawn out or compensated as they are in a butt-strap riveted job when the inequalities are slight. There is thus created the hazard of a cracking stress at the joint similar to the development of cracks in a lap-joint boiler. This alone is a feature that should not be overlooked. While makers of welding equipment can make up a demonstration job satisfactory under all tests, I venture the opinion that the welding trade is no exception to the average of human nature and that it has its quota of incompetent men, with the unfortunate disadvantages that their inferior work is not as readily detected as is an improperly driven rivet.

I believe that rules for vessels carrying gases under pressure or liquids that may generate gases should be just as strict as to construction as the A.S.M.E. Code for unfired pressure vessels. Welding should be limited to vessels of small sizes, low pressure and short joints.

Vessels likely to collect oil should be set so that they may be drained completely, and operating regulations should make certain that they are drained frequently.

With respect to the welding of steam-pipe joints, it seems to me that this is a new art as applied to high-pressure steam pipes, and I believe that data are somewhat meager as to the effect of age, expansion, drains, vibration and similar factors on the durability of the joints. In particular, where a branch joins a main header at right angles, I believe that it would be a good safety feature to install a horseshoe-shaped clamp around the main and join it to the branch. This should be made strong enough to stand the reaction of steam blowing, so that in case of a tear at the weld it would not separate them far enough to do the serious damage that a complete rupture would cause.

Incidentally, I might call attention to the fact that makers of cutting and welding gases are not packing any in torch-welded containers. They take good care that they use something reliable, so they employ a cup-drawn tube bottle.

West Albany, N. Y. FRANK L. GILLMOR.

Why Induction Motor Failed to Start

Probably through an oversight in the article, "Why Induction Motor Failed to Start," by J. H. Bender, in the Dec. 29, 1925, issue, the author has the polarity

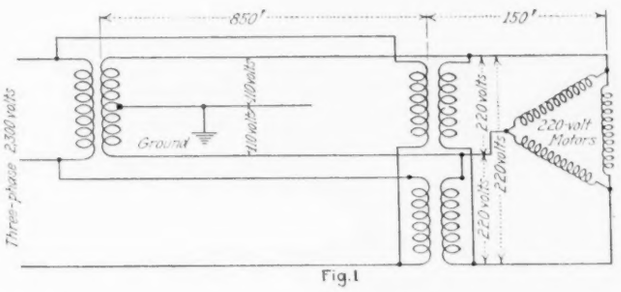


Fig. 1

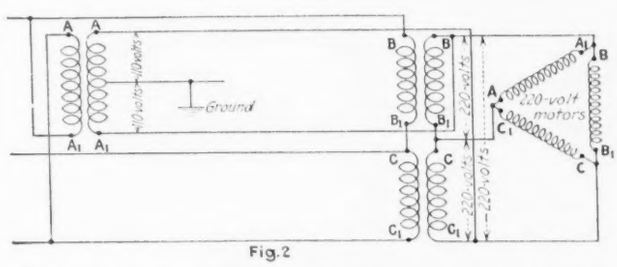


Fig. 2

Figs. 1 and 2—Incorrect and correct connections of transformers

of one of the transformers reversed in Fig. 2, shown herewith as Fig. 1. This connection would cause a short-circuit of the transformer bank. The connections should be made as in Fig. 2.

The polarity in the diagram can be checked by connecting the transformer in a simple delta connection shown for the motors on the diagram. Then letter the connections as indicated and make the transformer connections correspond to this as in the diagram. If the motor delta connection were broken at *A* and *C* and the *A* phase moved up to a vertical position and the *C* phase moved down to a vertical position, the *A B* and *C* terminals would be on top and the *A*, *B* and *C* terminals on the bottom. This is the relation shown on the transformer, and the same lettered terminals are connected on the transformer as on the motors.

Woodward, Okla. HARRY J. ACHEE.

New and Improved Equipment

Combustion Steam Generator

A type of boiler in which the area of the heating surface for a given output has been materially reduced, through exposing practically the entire heating surface to the radiant heat of the fire, and the limitations on the furnace temperatures imposed by the refractories comprising the boiler furnace have been obviated, has been recently announced by the Combustion Engineering Corp., 43 Broad St., New York City.

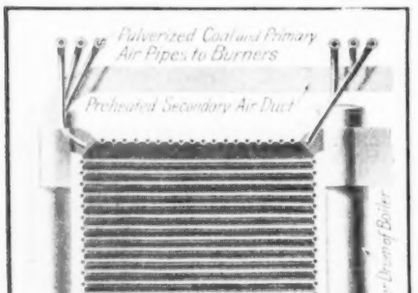

Pulverized Coal and Primary Air Pipes to Burners
Preheated Secondary Air Duct
Lower Drum of Boiler
Water Tubes forming Furnace Wall

Fig. 1—Plan of combustion chamber at a point between upper drums and burners

The boiler consists of four drums with interconnecting water tubes. The large drum shown at the upper left-hand corner in Fig. 2 serves as a steam and water drum and is fed from the regular feed-water supply.

Three other drums, placed as shown, are interconnected with water tubes which form two sides, top and water screen of the furnace. Headers connected with the steam drum and lower right drum and interconnected with water tubes, form the other two walls of the furnace.

The vertical tubes forming the four walls are of the fin type, that is, each tube has two longitudinal steel fins welded on it diametrically opposite each other and when placed in position the fins meet, thus presenting a continuous water-cooled surface to the radiant heat of the furnace.

Water circulation between the steam drum and lower right drum, from which all the tubes are supplied, is through two rows of five tubes each located outside of the boiler setting, as indicated in Fig. 2.

The coal and primary air are supplied through a distributor located above the boiler to burners placed in each of the four corners of the furnace, a short distance below the drums. Each burner has a series of nozzles and is directed to give a turbulent action in the combustion chamber. From the point of combustion the flame and gases pass downward through a multi-tubular water screen formed by the connecting tubes between the two lower drums, thence through a chamber to the superheater and finally through the air preheater to the stack or induced-draft fan as the case may be.

The secondary air for combustion enters the air heater at the top and passes through it in the opposite direction to that of the gas, being finally discharged to the burners through sheet-metal ducts carried around the boiler setting. Some of the advantages claimed for this boiler by the manufacturer are the large reduction in heating surface for a given output, and quick pick-up of load, owing to the large surface exposed to the radiant heat of the fire, flexibility of the heating surface arrangement and water circulation provided. Another advantage claimed is the absence of refractories.

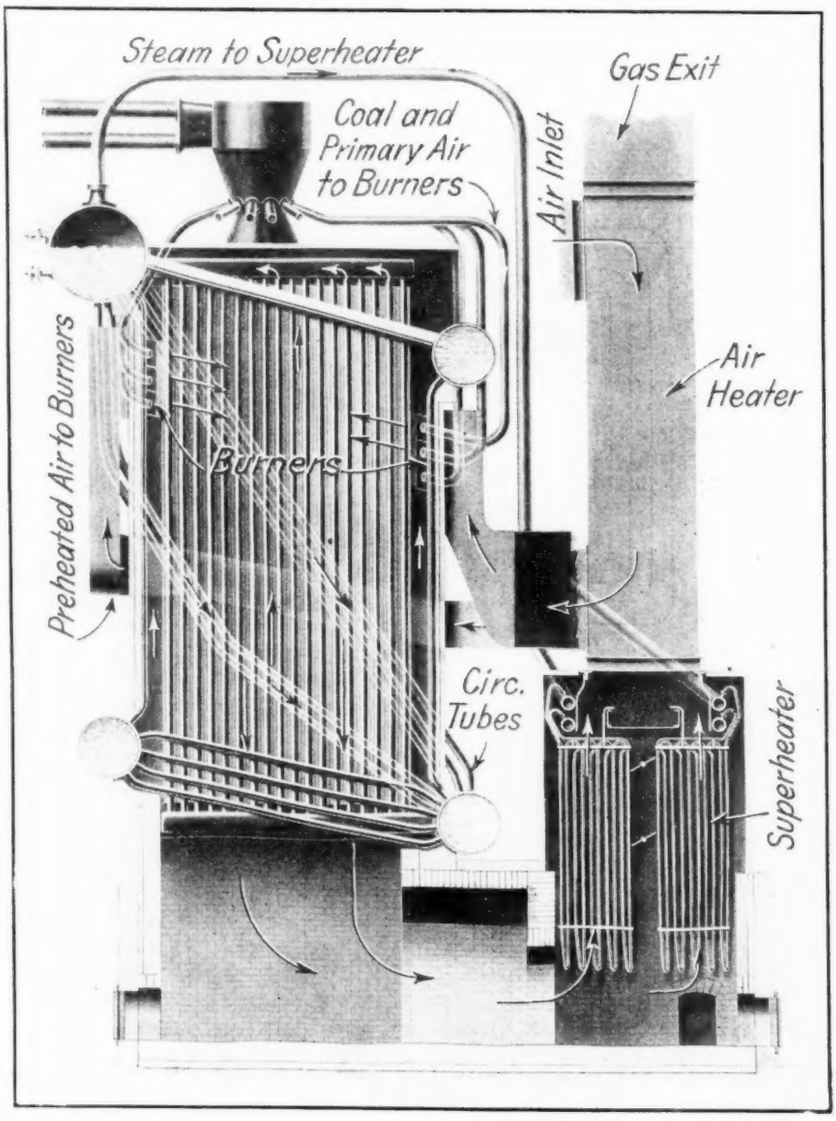


Fig. 2—View showing general arrangement of boiler superheater and air heater

News in the Field of Power

Governor Smith of New York Demands Water Power Commission Be Abolished

Smith Calls for Repeal of Miller Act—Hughes Reorganization Commission To Hold Final Meeting on Feb. 11—Bills Carrying Out Governor's Ideas Introduced

GOVERNOR SMITH of New York State, in his message delivered to the Legislature in Albany on Feb. 1, urges state development of the water powers that still belong to the state by the state itself instead of granting rights for their development to private corporations. Incidentally, he made a direct appeal to the Hughes Commission, which is at present at work on a plan for the reorganization of the state's departments, to include in its report to the Legislature a clear-cut definition of what should be the state's policy with regard to its water power. The report of the New York State Water Power Commission in regard to the Niagara and St. Lawrence River which caused the message to be delivered was summarized in *Power*, Feb. 2, page 198. The Governor's message in opposition to the recommendations made in this report is, in part, as follows:

Water power is the last of our state's great resources still remaining in the hands of the people themselves. In no unmistakable terms the people, in the fall of 1923, rejected an amendment to our constitution which would have permitted the development of water power in the Adirondacks by private corporations. This referendum vote was widely discussed, and brought about an understanding of the water power problem such as we never had in this state before.

The history of all the grants of water power at Niagara Falls should in itself be sufficient to condemn the policy of giving away for small annual rentals these great properties which should be preserved for our use and the use of our children. The wasteful policy of the past is emphasized by the report of the commission itself when it says:

"The commission in the past year has largely devoted its attention to securing adequate compensation for the use of state-controlled waters from these companies which for years have been using these waters without fully compensating the state for the privileges enjoyed."

The two great sources of hydro-electric energy are at Niagara Falls and on the St. Lawrence River. Corporations eager to get control of these water powers have been working on the project for years.

As far back as 1907, by special charter the right to develop at the St. Lawrence River was granted to the Long Sault Development Company, which special charter was repealed by the Legislature in 1913. In no way discouraged during all the years that have passed, private corporations still have their eye on the great power possibilities of the St. Lawrence River.

Both of these places may be said to be the key to comprehensive power development. The small inland rivers and streams and surplus waters of the canal produce only sufficient power when hooked up to the main source to be able to take care of the peak load. The basis of firm, steady, all-the-year-round power is at the two places mentioned and spoken of in the report of the Water Power Commission. If both of these sources of supply fall into the hands of private companies, possibility for future state development will be lost forever.

Great projects are now under way all over the country for power developments, reclamation, irrigation, port development, tunnel construction and similar undertakings through public or municipal corporations, created by sovereign states investing such corporations with the power to own, construct and, in many cases, operate great public improvements, and with the power to issue their own bonds exempt from state taxation.

There is, therefore, nothing new or untried in the proposal that I make. Furthermore, the state is already engaged in the business of producing electrical energy. The power plants at Crescent Dam and Visschers Ferry on the canal belong to the State of New York. The legislation required to make the reorganization amendment effective will have to provide for the abolition of the State Water Power Commission.

OPPOSES ELECTIVE OFFICERS ON BOARD

If the present program is carried on, however, there will be no need for any further talk about power commissions, as the state will have given away the two great sources of water power development.

I recommend that the State Water Power Act be immediately repealed and in its place the state water power authority be set up in the Conservation Commission and charged with the duty of preparing a plan for comprehensive development at the earliest possible moment.

This is a definite proposal that is practical and capable of immediate usefulness. It adds no financial burden to the state and at the same time permits the state to develop its own resources immediately and puts the state in a position to participate in any interstate or international projects, protecting at the same time our own rights and conserving them for the benefit of all our people.

According to the press, the executive committee of the Hughes Reorganization Commission, which consists of the chairmen of the various subcommittees, met on Feb. 6 to put its recommendations in final form to be passed upon by the whole commission at a meeting in New York on Feb. 11.

Bills introduced by Senator Nathan Straus, Jr., and Assemblyman Frederick L. Hackenburg carrying out the Governor's recommendations, were referred on Feb. 2 to the fiscal committees of the two houses with the Governor's message. The bills probably will die there, as there appears no indication that any of the majority leaders have been won over to the Governor's policy of state development.

Visscher Ferry Plant Started Jan. 25

Generation of current at the state hydro-electric plant at Visscher Ferry, near Troy on the Mohawk River began Jan. 25, according to announcement by the Adirondack Power & Light Corp. which operates this plant. When tests of equipment were made recently by officials of the General Electric Co. and the power company, everything was found to be ready for operation.

Power Commission's Hearings on Conowingo To Be Feb. 12

The Federal Power Commission at its Jan. 29 meeting authorized its executive secretary to hold a public hearing in Baltimore, Feb. 12 to consider the federal questions involved in the issuance of securities in connection with the Conowingo development. It will follow a hearing on the same subject to be conducted by the Maryland authorities.

Philadelphia Electric Co. Reduces Rates

The Philadelphia Electric Co. has announced a reduction in rates effective March 1. The new rate schedule has been filed with the Public Service Commission in Harrisburg.

The company's increase in business and efficiencies in management and operation are given as the reason for the reduction. W. H. Johnson, president of the Philadelphia Electric Co., in a statement said:

The rate reduction is attributable to greatly increased volume of business and greatly increased economies, adding that the reductions have resulted in a fairly even distribution in savings to all classes of customers.

He said that his company is furnishing large blocks of power to the other public utilities of the city, as well as to neighboring light and power utilities in Pennsylvania and New Jersey by means of interconnections. He said that it is with these things in view and with the desire of obtaining added economic advantages for the public that his company is endeavoring to utilize "the only at present available water power in this section at Conowingo, and at the same time laying our plans to complete the colossal steam Richmond station on the Delaware River."

Pulverized Coal Tests for Steamships Begin Feb. 10

Captain C. A. MacAllister, chairman of the fuel conservation committee of the Shipping Board, said on Jan. 31 that the first of an extended series of tests to study the practicability of pulverized coal as fuel on board steamships will begin at the League Island Navy Yard, Philadelphia, about Feb. 10.

The Fuller-Lehigh Coal Co. held a preliminary test at its mines in Fullerton, Pa., recently and will move the apparatus of the pulverized coal-burning plant to the Philadelphia navy yard this week.

The question of burning pulverized coal on ships has attracted the attention of shipping men throughout the world. The mounting cost of fuel oil has caused the shipping industry to seek a substitute, and several pulverized coal burners have appeared on the market.

Captain MacAllister expects a large delegation of shipping men to be present at the test. The Shipping Board, Bureau of Mines and the Navy Department will be represented.

President Coolidge Gives Committee Advice on Muscle Shoals

Committee in Accord with President's Wishes Votes Down Amendments —American Farm Bureau Concurs with President's View— Senator Norris Not Discouraged

THIRTY minutes before the Agricultural Committee of the Senate was scheduled to begin its final session for the consideration of the House Muscle Shoals resolution, members of the committee, in response to a request by the President, assembled at the White House and were urged by the Chief Executive to report out the concurrent resolution without amendment. He explained that he thought the matter should be settled and that the resolution as passed by the House seemed to be the most promising method of obtaining results.

Resolution Permits One Bid Only

The President was frankly told by some of his callers that they feared the phraseology of the House resolution would result in confining bids to a single company which would not be particularly interested in distributing the power not needed for fertilizer purposes. Mr. Coolidge was not convinced, however, and expressed the hope that they would see their way clear to allow the resolution to go to the Senate calendar without change of phraseology.

When the committee re-assembled the various amendments proposed were voted down, and the bill reported without change in accord with the President's wishes. The amendments, however, will be presented again on the floor of the Senate. The principal changes proposed were the elimination of the reference to the Ford offer; provision for the distribution of all power not needed for fertilizer purposes "within the full radius of economic use," and for the distribution of the excess power under the conditions of the Federal Water Power Act.

The Senate Committee agreed to continue its investigations of the Muscle Shoals situation. As soon as the tax bill is out of the way, hearings will be resumed.

The House resolution gives no final authority to the Joint Congressional Committee which is "directed to conduct negotiations for a lease of the nitrate and power properties." That committee will have to report its recommendations to Congress, which means that the Senate committee on agriculture then will have another opportunity to insert conditions under which a lease may be made.

Farm Bureau Approves Resolution

The Washington representative of the American Farm Bureau Federation, in a communication to the members of the committee, requested, under date of Jan. 22, that

> House Concurrent Resolution No. 9 be reported out of the Committee on Agriculture and Forestry without change or amendment. This will greatly expedite the progress of this legislation and will enable the Joint Congressional Committee provided for in this resolution to recommend back to Congress a lease, which Congress either can reject or accept.

Senator Norris commented as follows on the President's action:

> This action by the committee is about as bad as the Ford proposition except that it proposes 50 years instead of 100 years.
>
> I think it fair to say that the committee would not have taken the action if let alone, but President Coolidge this morning sent for seven members. He didn't get all seven, but he did get enough to bring the resolution out.
>
> I do not feel at all discouraged about the vote. It is probably remarkable that the President did not control more votes than he did.
>
> I don't expect the resolution to be accepted by the Senate.
>
> Its viciousness will be and is now being recognized by the people of all the Southern States. Only in the last week or so have the people of the South awakened to what was being done. And the rumor will not die that the bill was fixed to fit a special bidder's case and that that bidder has his bid all ready to present. It is perfectly foolish, of course, to think that the joint committee proposed, even if appointed today, could make the necessary investigation of all bids and decide by April 1, as provided in the resolution.
>
> I do not expect the resolution to pass the Senate. Senator Smith's bill and my own bill, both providing for government operation, will yet be heard from. The agricultural committee will hold hearings on each bill in the near future.

The Tennessee Manufacturers' Association makes these points:

> The resolution is silent with respect to the distribution and sale of power not needed for national defense or for fertilizer manufacture. There is tremendous interest throughout the South in that phase of the matter. Industry makes no claim to power which now or in the future may be needed for war purposes or for fertilizer. Industry is interested vitally in the production of cheap fertilizer as it realizes this would contribute greatly not only to agricultural development but to industrial development. Muscle Shoals is the only possible source of water power for a large section of the South.
>
> The great values of power from Muscle Shoals should not be used to subsidize anybody. The power not needed for war purposes or for the production of fertilizer should be sold for distribution to the public under regulation subject to recall, if, when and as needed for war purposes or fertilizer.

Muscle Shoals Plant Working Perfectly

In the course of testimony before the Appropriations Committee of the House, Gen. Harry Taylor, the Chief of Engineers, referring to the dam and power plant at Muscle Shoals, said:

> We started one of the generators with a load on the 12th of September, and began to build the load up about 10 o'clock in the forenoon and by noon it was built up to 24,000 kilowatts. It ran full load for a month without the slightest hitch and we have not had a hitch yet. I think that is something that has seldom if ever occurred in any plant of that size in the country. The other generators have gone exactly the same way. There is not a thing down there that we have discovered yet that gives us the slightest trouble. We know that there is no water going through the dam or underneath, because during the summer, when the river was down, the north channel was practically dry. No water came by that end of the dam. We examined the river bed all down below the dam, all over the bed of the river for half a mile below, and there was not the slightest indication of water getting by anywhere. At the south abutment there are about two cubic feet per second going by around the end of the dam, but we know where it comes from and the reason why it is going by, but it is not worth while to stop it.

San Diego, Calif., To Increase Capacity of Station "B"

The San Diego Consolidated Gas & Electric Co. expects to spend over $1,500,000 in new construction and equipment for Station B power plant. These improvements will increase the capacity of the station to 47,000 hp. and include the purchase and installation of a new 20,000-hp. turbine with auxiliary equipment and one additional boiler of 11,000 sq.ft. of heating surface.

Feather River May Have Five Power Houses

The Oroville-Wyandotte Irrigation District has applied to the Federal Power Commission for a preliminary permit covering a power project on the South Fork of the Feather River in Butte and Plumas Counties, California. Two schemes of development are proposed. Under the first plan there will be five power houses which will develop a maximum of 80,477 hp. Under the alternate plan there would be three power houses developing a total of 74,625 hp.

Bureau of Mines Studying Mechanism of Corrosion

A study of the mechanism of corrosion and the factors effective in its control in steam power plant operation is being conducted by the Bureau of Mines, at its Pittsburgh, Pa., experiment station. The purpose of this investigation is to obtain data on the amount of hydrogen concentration that should be maintained in the boiler water in order to reduce corrosion to a negligible proportion. In economizer tubes and feed lines especially, dissolved oxygen in the water causes a great deal of corrosion. Elimination of dissolved oxygen can be partly effected by deaëration, but this does not wholly remove the oxygen. If the hydroxyl concentration can be controlled to suit the conditions, it can be utilized to control the oxygen.

U. S. Civil Service Needs Architects and Engineers

The United States Civil Service Commission announces its need for architects and engineers for the Supervising Architect's Office to carry out the plan for public buildings, $165,000,000 being provided for in bills now pending before Congress. Applications will be received until April 10 for positions of architects, associate architects, assistant architects, associate and assistant architectural engineers, associate and assistant mechanical engineers, and associate and assistant structural engineers. Competitors will not be required to report for examination, but will be rated on their education, training, experience and specimens of their work filed with the applications, rating on which will begin March 15. Entrance salaries range from $2,400 to $3,800. Information and application blanks can be obtained from the Civil Service Commission at Washington, D. C., or at the post office or custom house of any city.

Large Engineering School for Middle West

Formal steps toward the merger of the Armour Institute of Technology with Northwestern University were taken on Jan. 9, when the trustees of the two institutions signed contracts detailing the affiliation plans.

The new school of engineering will be known as the Armour College of Engineering of Northwestern University. Expansion to three times its size of the Swift Hall of Engineering at Northwestern will be one of the outstanding plans of the new organization, and it is expected that this will be the finest school of engineering in the Middle West if not in the whole country.

Plans for the A.S.M.E. Regional Meeting

The A.S.M.E. Regional Meeting that is to be held in Providence, R. I., May 3-6, will probably have eight technical sessions. Two of these will consider subjects of interest to the machine shop, one session each will be devoted to industrial power, wood industries, central station power, textiles, education and training for the industries. Luther D. Burlingame will be the chairman. An all-day trip will be taken to the Newport Torpedo Station on May 6. A reception will be held on Monday evening, a Rhode Island Clambake will be on Tuesday, and an informal dinner, dance and card party on Wednesday. Many excursions will be made to points of interest in and about Providence.

New Jersey Rejects Proposed Tri-State Delaware Compact

Rejection of the proposed tri-state compact for the control of water resources of the Delaware River was recommended in a report of the New Jersey Water Policy Commission to the Legislature on Feb. 2. The commission recommended that the negotiations be continued and that a commission be created to negotiate a compact between New Jersey and New York defining their rights to interstate streams, including the Hackensack, Ramapo, Pochuck and Wallkill rivers.

Uncertainty as to how much water New Jersey, Pennsylvania and New York would get under the agreement was one of the chief faults found.

The tri-state compact, which was one of the eight subjects cited by Governor Pinchot for calling the special session of the Pennsylvania Legislature, was the subject of a special hearing at Harrisburg on Feb. 2 before the House Manufacturers' Committee.

Philip P. Wells, member of the Tri-state Treaty Committee, asserted the compact was necessary to control the waste of flood waters. He said the development of 400,000 hp. was possible in the Delaware through proper storage obtained by proper regulation.

S. T. Matlack, representing the Lehigh Coal & Navigation Co.; John H. Bigelow, Hazleton, and Berne E. Evans, Harrisburg, opposed the compact, asserting that its distribution of waters was improper and that it would give New York City the right to divert water for municipal uses to the detriment of Pennsylvania industries.

Crude Petroleum Production Decreases

The production of crude petroleum in the United States for the month of December, 1925, as reported to the Bureau of Mines, amounted to 60,943,000 bbl., a daily average of 1,966,000 bbl. This represents a decrease from November production of 83,000 bbl. per day or 4 per cent, the lowest daily average production since March. The Appalachian district was the only one to show an increase in production, losses being again recorded in California and the states of the mid-continent field, as well as in the Rocky Mountain district, the production of which had been on the increase for some time.

The total production of crude petroleum in the United States for the year 1925, measured by pipe-line runs, amounted to 755,852,000 bbl.

Stocks of crude petroleum east of California continued to drop, the total of 292,288,000 bbl. on hand Dec. 31, 1925, being a decrease from the previous month of over four million barrels. Unlike the previous month, the refinery stocks increased slightly, and the 4 million decrease was in pipeline and tank-farm stocks. Total stocks east of California were 20 million barrels lower on Dec. 31, 1925, than at the beginning of the year. For the first time in over a year stocks of crude petroleum (including fuel oil) in California decreased.

Stocks of lubricants again rose to a record high figure. Stocks of gas and fuel oils east of California were again drawn on, being reduced more than 100,000,000 gallons.

According to the press the various grades of crude oil produced in the mid-continent fields were advanced from 25 to 89c. a barrel, under the new schedule of prices put into effect on Feb. 1, by the leading crude-oil purchasing companies in the Middle West. The advance in crude oil prices has been expected for several weeks, and is due primarily to the sharp decline in the production of crude oil during the last few months.

Conference on Conservation of Power in Industrial Plants Program

At Engineers Club of Philadelphia, Feb. 16

MORNING — Dr. Arthur M. Greene, Jr., Princeton University, presiding: "Power Transmission Economics," by William Staniar, du Pont Co.; "Lubrication and Bearings," by John D. Gill, Atlantic Refining Co.; "Economy Due to Power Factor Correction," by Erb N. Dittenhofer, Gotham Silk Hosiery Co.; "Plant Illumination," by Ward Harrison, National Lamp Works.

Afternoon—Dr. Robert H. Fernald, University of Pennsylvania, presiding: "High Pressure Prime Movers in Industrial Plants," by Francis Hodgkinson, Westinghouse Electric & Manufacturing Co.; "The Use of Exhaust Steam for Process Work in Textile and Other Industrial Plants," by Samuel M. Greene, consulting engineer; "Heat Insulation," by L. B. McMillan, Johns-Manville, Inc., and R. H. Heilman, Mellon Institute of Industrial Research.

Evening—Major Clayton W. Pike, president of the Engineers' Club of Philadelphia, presiding: "Economic Factors Governing the Purchase or Generation of Power," by David Moffat Myers, consulting engineer; "Operating a Private Power Plant in Competition with Purchased Power," by Thomas V. Balch, supervising engineer, Equitable Office Bldg., New York City; "Operating with Purchased Power in Competition with Private Power," by Reginald P. Bolton, consulting engineer.

Travel Routes and Costs in South America

American traveling men are going to Latin America in ever-growing numbers, according to *Commerce Reports*. Many difficulties have been encountered because of insufficient knowledge as to exact traveling conditions and facilities in each country. To assist the executive and export manager in planning his salesman's trip in South America, the Latin American Division of the Bureau of Foreign and Domestic Commerce, has issued T. I. B. 381, "Travel Routes and Costs in South America." This completes the series of suggested salesmen's travel routes for the Latin American region. This report may be obtained through the Bureau's district or co-operative offices or from the Superintendent of Documents, Government Printing Office, Washington, D. C. Price, 10 cents.

Chief Marine Engineer Wanted by Government

The United States Civil Service Commission announces an open competitive examination for a chief marine engineer to fill vacancies in the United States Coast and Geodetic Survey at $170 up to $245 a month, plus $1.25 a day for subsistence. Applications for this position will close March 9.

The duties are to assume full contro. of motive power and all machinery, including steam and electrical auxiliaries and internal-combustion engines of ship's launches; to operate and maintain this machinery during a surveying period in an isolated locality with the limited machine-shop facilities on the vessel; to prepare detailed specifications and estimate cost of repairs to machinery; to overhaul machinery and make minor repairs with the engine room force, and to supervise machinery repairs when performed under contract with a machine shop.

Competitors will not be required to report for examination at any place, but will be rated on their physical ability, and education, training and experience.

American Brown Boveri Buys Two More Companies

The American Brown Boveri Electric Corp. announced recently that it had acquired two additional properties, the Railway & Industrial Engineering Co. of Greensburg, and the Electric Development & Machine Co. of Holmesburg. These latest acquisitions will considerably amplify the present line of American Brown Boveri products.

The newly acquired companies specialize in high-tension switches and protective equipment for power companies.

Heat-Flow Meters Being Studied

A study of heat-flow meters for furnace walls is being conducted by the Bureau of Mines. The purpose is to develop meters for the measurement of heat flow from kiln walls, boiler settings, surfaces of coal in mines, and similar problems. Seven meters have been constructed, 2 ft. square and about 3/22 in. thick, and have been partly calibrated by passing known rates of heat flow through them. When the calibration has been completed, they will be available for special investigations on the flow of heat through refractory walls and for obtaining a measure of the radiation from boilers, kilns etc., during an efficiency test.

Checking Erosion at Niagara Being Considered

Negotiations looking to the checking of the erosion of the crest of Niagara Falls are in progress between the governments of Canada and the United States. Since the question of diverting more water for power purposes would give rise to controversy, it is believed that the United States hopes the question of recession at the Falls can be considered without reference to power questions.

The Canadian authorities, judging from press comment in Canada, are of the opinion that the two questions are inseparable.

The need for taking action at the earliest possible moment to protect the Falls is recognized in the Dominion as it is here. The need for more power is probably greater on the American side, but Canada does not have to reckon with numerous organizations that will see in any further diversion at Niagara Falls a step likely to mar their scenic beauty. The consensus of engineering opinion is that one of the best ways to enhance the scenic beauty of the Falls and to reduce recession is to distribute the water passing over the crest and reduce its volume. A thin sheet of water spread over the entire width of the Falls is the condition most desired to secure the maximum scenic beauty, many engineers have pointed out.

According to the Canadian press the authorities there believe the questions involved should be taken up for preliminary discussion by representatives of the two governments to be appointed for the purpose. Apparently, the thought is that were General Edgar Jadwin and some Canadian engineer of equal eminence, for instance, named by their respective governments, they could submit early recommendations for the most practical way to proceed.

Philadelphia Electric Co.'s Former Head Dies

Joseph B. McCall, chairman of the Board of the Philadelphia Electric Co., died suddenly in the Hotel Traymore, Philadelphia, on Jan. 29, at the age of 56. He had been in ill health for three years and had gone to Philadelphia with his wife for a rest about two weeks ago. Mr. McCall consolidated the small neighborhood electric companies of Philadelphia into the Philadelphia Electric Co. in 1899 and became its first president, building up this large organization to its present prominence. Ill health obliged him in 1924 to relinquish the presidency for

Joseph B. McCall

the chairmanship of the Board. He was born in New York City and went to Philadelphia when a boy. From 1904 to 1907 he was president of the Association of Edison Illuminating Companies and later was a vice-president of the N. E. L. A. He was a member of the A. I. E. E. and of the Franklin Institute of Philadelphia. He leaves a widow, a daughter and a son.

Personal Mention

George A. Walkem, consulting engineer, Vancouver, B. C., was elected president of the Engineering Institute of Canada at its recent meeting.

E. W. Lloyd, general contract agent for the Commonwealth Edison Co. for the last nineteen years, has been elected a vice-president of that organization. Mr. Lloyd has been active in the N. E. L. A., having been past-president and at the present time is serving as chairman of the Commercial Section.

Robert L. Watts, of Lewis & Watts, Engineers, Portland, Ore., is leaving this firm to join the Compressed Spruce Products Co., Inc., which has built a new plant at 90 Main St., West Orange, N. J., for the production of pulleys, gears, conveying equipment, wheels, etc., made from compressed spruce.

S. Z. De Ferranti, inventor and engineer, has been made an honorary member of the British Institution of Electrical Engineers. Mr. Ferranti was a pioneer in the development of the electrical industry, and his inventions in various lines are among the most notable contributions to the industry's progress. He is a past-president of the Institution.

Obituary

Arthur R. Bush, manager of the industrial department of the General Electric Co., died at his home in Schenectady on Jan. 24. Mr. Bush was born in Fall River, Mass., in 1861, graduated from Annapolis in 1882 and served two years in the United States Navy. In 1884 he entered the employ of the Edison Company, following which he was connected with the New England Wiring & Construction Co. In 1892 he was made district engineer of the Edison General Electric Co. in the New England district, resigning this position in 1904 to accept the vice-presidency of the Union Bag & Paper Co. He remained with this concern until 1906, when he returned to the General Electric Co., where he became manager of the power and mining department, and later manager of the industrial department.

Rear-Admiral Albert B. Willits, U. S. Navy, retired, who died on Jan. 7 in the Naval Hospital at Philadelphia, was born in 1851 and after his preliminary education entered the Naval Academy as a cadet engineer with the class that graduated in 1874. Among the various positions that he held was that of past assistant engineer in charge of the engines at the trial of the gunboat "Yorktown" in 1889, which was one of the first installations of high-speed machinery in the Navy. At the conclusion of the cruise on the "Yorktown" he was assigned as one of the assistant inspectors for the "Columbia" and later for the "Minneapolis"; these boats being for several years the fastest large vessels in the world, having attained a speed of over 23 knots and more than 20,000 hp. Later he became chief engineer of the "Minneapolis." At the outbreak of the Spanish-American War he was ordered to duty in the Bureau of Steam Engineering, as an assistant to Admiral Melville, where he continued until 1901. It was during this period that tests on one of the boilers of the U. S. S. "Cincinnati" were made. These tests were valuable as a source of data regarding temperatures in various parts of the boiler at various rates of combustion, which included one at 60 lb. of coal per sq.ft. of grate surface. He was chief engineer of the Norfolk Navy Yards from 1904 to 1908 and was promoted through the various grades, attaining the rank of rear admiral in 1911, and was during the World War inspector at the Babcock & Wilcox Co. Works. Beside being a contributor to the technical journals he was for a time editor of the *Journal of the American Society of Naval Engineers.*

Society Affairs

The Atlanta Section of the A.S.M.E. will hold a meeting on Feb. 18 at which "The Diesel Engine Today and Its Probable Future Development," will be considered by N. B. Henry, works manager of the Murray Co., Atlanta, Ga.

The Eastern New York Section, Schenectady Branch of the A.S.M.E., will hold a joint meeting with the **A.I.E.E.** on Feb. 12 at which Mr. Eveleth, manager of the G. E. Schenectady plant will be the speaker.

The Columbus Section of the A.S.M.E. will have as the subject for its Feb. 12 meeting, which will be held in the Columbus Railway, Power & Light Co. Auditorium, "Powdered Fuel," by T. A. March, of the Combustion Engineering Co., of Chicago.

The Houston Section of the A.S.M.E. will hold its Feb. 16 meeting at the Deepwater power plant. It will include a visit of inspection of the plant, which has just been converted to natural gas from fuel oil. W. A. McDonald, superintendent of power, Houston Light & Power Co., will be the speaker.

The Connecticut Section of Civil Engineers will hold its annual meeting on Feb. 16-17 at New Haven in the Mason Laboratory. "Some Aspects of the Proposed Tidal Power Development of Eastport, Maine," by Dexter P. Cooper, will be a paper of interest to *Power* readers.

The Plant Engineers' Club of Boston will visit the new Edgar station, formerly called the Weymouth station, of the Edison Electric Illuminating Co. of Boston on Feb. 10. The visit will be followed by an informal dinner at the Boston City Club, after which there will be a discussion by the members on "Purchased Power vs. Plant Power."

The Washington, D. C., Section of the A.S.M.E. will hold a meeting at Cosmos Hall on Feb. 12. "Estimate of Power for Ship Propulsion and the Methods Employed at the U. S. Naval Model Basin," by Commander E. L. Gayhart, will be the attraction. Arrangements are being made for demonstration of actual operation of the Model Basin at the Washington Navy Yard.

Business Notes

Morey, Jones & Lovell, 810 West 6th St., Los Angeles, Calif., is the new name of the recently reorganized engineering firm of Hanson, Jones & Morey, who handle liquid flow meters, transformer oil-cooling equipment, etc.

The Terry Steam Turbine Co., Hartford, Conn., announces the appointment of Fraser & Chalmers, of Canada, Ltd., with offices in the Canada Cement Bldg., Montreal, as its sales representative for the provinces of Quebec, Nova Scotia, New Brunswick and Ontario.

Diamond State Fibre Co., Bridgeport, Pa., near Philadelphia, announces that: C. M. Bogert is now district manager for the State of Connecticut, with offices at South Norwalk; W. R. Elsenhans, formerly of the Bridgeport office staff, is now district manager at the Philadelphia office at 822 Drexel Bldg.

Coming Conventions

American Boiler Manufacturers Association. D. W. Glanzer, 810 Rockefeller Bldg., Cleveland, Ohio. Meeting at Mid-Day Club, Cleveland, Ohio, Feb. 12. Annual convention at Homestead, Hot Springs, Va., May 31-June 2.

American Chemical Society. Charles L. Parsons, Mills Bldg., Washington, D. C. Convention at Tulsa, Okla. April 3-6.

American Institute of Electrical Engineers. F. L. Hutchinson, 29 West 39th St., New York City. Annual convention at White Sulphur Springs, W. Va., June 21-25.

American Institute of Mining & Metallurgical Engineers. Dr. H. Foster Bain, 29 West 39th St., New York City. Annual meeting at Engineering Societies Bldg., New York City, Feb. 15-17.

American Society for Testing Materials. C. L. Warwick, 1315 Spruce St., Philadelphia, Pa. Convention at Haddon Hall, Atlantic City, N. J., June 21-25.

American Society of Mechanical Engineers. Calvin W. Rice, 29 West 39th St., New York City. Spring convention at San Francisco, Calif., June 28-30.

American Water Works Association. W. M. Niesley, Assistant to Sec., 170 Broadway, New York City. Annual convention at Hotel Statler, Buffalo, N. Y., June 7-12.

American Welding Society. M. M. Kelly, 29 West 39th St., New York City. Annual convention at 29 West 39th St., New York City, April 21-23.

Association of Iron & Steel Electrical Engineers. John F. Kelly, 1007 Empire Bldg., Pittsburgh, Pa. Exposition and convention at Hotel Sherman, Chicago, Ill., June 7-10.

Electric Power Club. S. N. Clarkson, B. F. Keith Bldg., Cleveland, Ohio. Convention at The Homestead, Hot Springs, Va., May 24-27.

Heating & Ventilating Exposition. E. P. Frenz, Hotel McAlpin, New York City. Exposition at new Madison Square Garden, New York City, Mar. 17-23.

Master Boiler Makers Association. Harry D. Vought, 26 Cortlandt St., New York City. Annual convention at the Statler Hotel, Buffalo, N. Y., May 25-26.

National Association of Stationary Engineers. F. W. Raven, 417 South Dearborn St., Chicago, Ill. Convention at Atlantic City, Sept. 6-11. Annual conventions and exhibitions of state association are scheduled as follows: **Indiana State Association,** F. L. Clifford, 653 South Union St., Kokomo, Ind., Convention at Lafayette, Ind., May 10-15; **Ohio State Association,** T. S. Garrett, 2622 E. Second St., Dayton, Ohio, Convention at Newark, Ohio, June 17-19; **Connecticut State Association,** George F. Klopfer, 30 East Pearl St., New Haven, Conn., Convention at Norwich, Conn., June 25-26; **New Jersey State Association,** S. G. Dalrymple, 111 Hutton St., Jersey City, Convention at Atlantic City, Sept. 12; **Pennsylvania State Association,** Frank J. McCarron, 3647 North 11th St., Philadelphia, Convention at Philadelphia, Sept. 12-13.

National District Heating Association. D. L. Gaskill, Greenville, Ohio. Convention at Niagara Hotel, Niagara Falls, June 1-4.

National Electric Light Association. A. Jackson Marshall, 29 West 39th St., New York City. Forty-ninth convention and manufacturers' exhibition, at Atlantic City, Young's Million Dollar Pier, May 17-21.

Power Show. International Textile Exposition—James F. Morgan, 53 Devonshire St., Boston, Mass. Power Show will be Department "D" of the International Textile Exposition, and will be under the auspices of the New England Association of Commercial Engineers, and held at the Mechanics Bldg., Boston, Mass., April 12-17.

Sesquicentennial International Exposition. Capt. Asher C. Baker, director in chief, Independence Square, Philadelphia. Exposition to be held in Philadelphia, Pa., from June 1 to Dec. 1.

Trade Catalogs

Wire—Rome Wire Co., Rome, N. Y., "Bare Copper Wire" is the title of a new bulletin recently issued by this firm. Beside illustrations showing the processes involved in producing this product many tables of sizes, etc., are included.

Condensers, Vent — The Cochrane Corp., 17th St. and Allegheny Ave., Philadelphia, Pa. "Vent Condensers and Their Uses," form the subject of Bulletin No. 666, which explains the advantages of vent condensers as applied to open heaters, hot-process water softeners and jet heaters, the vent condenser permitting ample venting of steam without loss of heat and without unnecessary loading of air pumps.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; **mine run** except Pittsburgh gas slack:

Bituminous, Net Tons	Market Quoting	Feb. 1 1926
Pool 1	New York	$2.85@$3.25
Smokeless	Boston	2.08
Clearfield	Boston	1.85@2.25
Somerset	Boston	2.00@2.40
Kanawha	Columbus	1.55@1.85
Hocking	Columbus	1.65@1.85
Pittsburgh	Pittsburgh	2.00@2.10
Pittsburgh gas slack	Pittsburgh	1.25
Franklin, Ill.	Chicago	2.35@2.65
Central, Ill.	Chicago	2.25@2.35
Ind. 4th Vein	Chicago	2.25@2.35
West Ky.	Louisville	1.25@1.50
S. E. Ky.	Louisville	1.40@1.75
Big Seam	Birmingham	2.00@2.25
Anthracite, Gross Tons		
Buckwheat No. 1	New York	*None in Market*
Buckwheat No. 1	Philadelphia	
Birdseye	New York	

FUEL OIL

New York—Feb. 4, light oil, tank-car lots; 28@34 deg. Baumé, 5¼c.@5⅝c. per gal.; 36@40 deg., 5½c.@5⅝c. per gal., f.o.b. Bayonne, N. J.

St. Louis—Jan. 25, tank-car lots, f.o.b. St. Louis; 24@26 deg., $2.05 per bbl.; 26@28 deg., $2.10 per bbl.; 28@30 deg., $2.15 per bbl.; 30@32 deg., $2.20 per bbl.; 32@36 deg., gas oil, 5.53c. per gal.; 38@40 deg., 6c. per gal.

Pittsburgh—Jan. 26, f.o.b. local refinery; 30@34 deg., fuel oil, 6c. per gal.; 36@40 deg., fuel oil, 6½c. per gal.

Dallas—Jan. 23, f.o.b. local refinery; 26@30 deg., $1.65 per bbl.

Philadelphia—Jan. 27, 27@30 deg., $2.31@$2.37 per bbl.; 18@22 deg., $1.75@$1.81; 13@19 deg., $1.68@$1.74 per bbl.

Boston—Jan. 28, tank-car lots, f.o.b. heavy oil, 12@14 deg. Baumé, 4¼c. per gal. light oil, 28@32 deg. Baumé, 5⅞c. per gal.

Cincinnati — Feb. 2, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 6½c. per gal.; 26@30 deg., 6⅞c. per gal.; 30@32 deg., 7c. per gal.

Chicago—Jan. 26, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 92c. per bbl.; 24@26 deg., $1.30 per bbl.; 26@36 deg., $1.35; 30@32 deg., $1.40@$1.45.

New Plant Construction

Ala., Albany—Decature Ice & Fuel Co. plans the construction of a 25 ton ice plant.

Ark., Batesville—A. T. Jenkins had plans prepared for the construction of a new 15 ton raw water ice plant complete with refrigeration equipment. Estimated cost $30,000. Engineer not announced.

Ark., Newport—Arkansas Light & Power Co., Picron St., Little Rock, plans the installation of a new 1,500 hp. unit in plant, here. Estimated cost $140,000. R. E. Burton, Little Rock, is engineer.

California — Pacific Gas & Electric Co., 245 Market St., San Francisco, is having plans prepared for the construction of a hydro-electric power development including a dam on the Mokelumne River at Salt Springs, canal and tunnel from dam to Tiger Creek and a power plant, 40,000 hp. capacity, etc. Company engineers in charge.

Calif., San Francisco—Park Commission, E. P. Lamb, Secy., plans to purchase 4 high pressure centrifugal pumps and motors for Golden Park Irrigation system.

Calif., San Jose—Pala School Dist., J. H. Bone, Clk., plans to purchase a deep well turbine pump, motor and controlling apparatus, etc.

Conn., Hartford—Travelers Insurance Co., 700 Main St., awarded contract for the construction of a 10 story office building on Grove St. to Marc Eidlitz & Son, Inc., 750 Main St. Estimated cost $1,500,000.

Conn., New Haven—Community Hotel Corp., 26 West 45th St., New York, N. Y., plans the construction of a 10 story hotel on Meadow St. here. Estimated cost $1,000,000. G. B. Post & Sons, 101 Park Ave., New York, N. Y., are architects.

D. C., Washington—A. L. Flint, General Purchasing Officer of the Panama Canal, will receive bids until Feb. 19 for two 75 kva., 25 cycle, 3 ph. 2,300 volt primary transformers, oil insulated, self-cooled, floor type.

Fla., Miami—Davenport & Rich Investment Co., is having plans prepared for the construction of a 15 story apartment at 34th and Bay Shore Aves. Estimated cost $3,000,000. Stuckert & Co., 1420 Chestnut St., Philadelphia, Pa., are architects.

Fla., Miami—Miami Ad Club Building Corp., is having plans prepared for the construction of a 12 story office and club building at Fourth St. and Bay Shore Drive. Estimated cost $1,500,000. Stuckert & Co., 1420 Chestnut St., Philadelphia, Pa., are architects and engineers.

Ill., Chicag —Commonwealth Edison Co., S. Insull, Pres., 72 West Adams St., awarded contract for the construction of first unit to storage and service building including boiler house, etc., at Twenty-second and Throop Sts. to J. W. Snyder Co., 307 North Michigan Ave. Estimated cost $1,000,000.

Ill., Chicago—B. Leo Steif & Co., 307 North Michigan Ave., Archts., is receiving bids for the construction of an 8 story apartment on Loyola Ave., for H. Emerman, 4750 Sheridan Road. Estimated cost $600,000.

Ill., Harvard—City plans to purchase a new pump for municipal waterworks. Estimated cost $2,000. H. Schultz, is engineer.

Ill., Jacksonville—City is having plans prepared for the construction of an electric power plant including the installation of two 500 kw. turbo generators and condensers, 300 hp. reservoir, stoker, etc. Estimated cost $100,000. H. L. Caldwell, is engineer.

Ia., Iowa City—Bd. of Education, W. H. Gemmill, Secy., Des Moines, will receive bids until Feb. 16 for the construction of a power and boiler house, including a 42 x 111 ft. generator unit, 62 x 112 ft. boiler unit, also coal and ash unit. Proudfoot Rawson & Souers, 810 Hubbell Bldg., Des Moines, are architects. Machinery has been purchased.

Mass., Charlestown (Boston P. O.)—J. D'Este, 26 Canal St., Boston, awarded contract for the construction of a boiler house, etc., on Spice St., here, to Whidden-Beckman Co., 100 Boylston St., Engr. Estimated cost $40,000.

Mich., Belle Isle (mail Tobins Harbor)—Dept. of Parks & Boulevards, H. W. Busch, Comr., Marquette Bldg., Detroit, is having preliminary surveys made for cleaning and restoring present canals, constructing small dams and sluiceways with electrically operated pumps to regulate flow and level of water in canals through Belle Isle. Estimated cost $25,000. J. A. Stringham is city research engineer.

Mich., Detroit—William Fox Film Corp., Fox Washington Theatre, plans the construction of a 12 story office and theatre building including steam heating equipment on Woodward Ave. Estimated cost $2,000,000. C. H. Crane, 542 Griswold St., is architect.

Mich., West Detroit (mail Detroit)—Michigan Central R.R., Detroit, awarded contract for engineering work and construction of a boiler plant here to Battey & Kipp, 123 West Madison St., Chicago, Ill. J. F. Dwimling, Detroit, is chief engineer. Bids have been taken on boilers, stokers, etc.

Miss., Mendenhall—W. C. Woods Lumber Co., is in the market for ice making machinery up to 10 ton capacity.

Neb., Omaha—A. H. Blank Theatre Co. will soon award contract for the construction of a 4 story theatre building including cooling plant, etc. Estimated cost $1,000,000. J. Eberson, 212 East Superior St., Chicago, Ill., is architect.

N. Y., Dunkirk—Bd. of Water Comrs., 425 Central Ave., will receive bids until Feb. 26 for the construction of a 6,000,000 gal. filtration plant and pumping station, including low service pumps, etc. J. N. Chester, Engrs., Union Bank Bldg., Pittsburgh, Pa., are engineers.

N. Y., New York—Bricken Construction Corp., A. Bricken, Pres., 62 West 47th St., plans the construction of a 42 story office building at Broadway and Barclay St. Estimated cost $10,000,000. Work will be done by separate contracts.

N. Y., New York—A. P. Hess, 345 Madison Ave., Archt., is having plans prepared for the construction of a 22 story hotel at 2 East 86th St. Estimated cost $2,000,000. Owner's name withheld.

N. Y., New York—Park Avenue Holding Corp., c/o Delano & Aldrich, 126 East 38th St., Archts., is having plans prepared for the construction of a 14 story apartment.

N. Y., New York—S. Sinsheimer, 877 Broadway, awarded contract for the construction of a 14 story loft building at 249 West 29th St., to Magoba Construction Co., 103 Park Ave. Estimated cost $1,000,000.

N. Y., Potsdam—Municipal Board, C. E. Haywood, Chn., Village Hall, will receive bids until Feb. 25 for the construction of a filtration and pumping plant, including two 200 hp. hydro-electric units. Bogart & Pohl, 30 Church St., New York, are engineers.

O., Cleveland—The Hotel Hollenden Co., C. H. Force, Secy. and Treas., East Sixth St. and Euclid Ave., awarded contract for the construction of a 10 story addition to hotel at Superior Ave. and East 6th St. to Craig-Curtiss Co., 4614 Prospect Ave. Estimated cost $1,000,000. Walker & Weeks, 1000 Euclid Bldg., are architects.

O., Gallipolis—Dept. of Welfare, J. E. Harper, Dir., Ninth and Oak Sts., Columbus, will receive bids until Feb. 18 for the construction of a power house for State Institution for Epileptics here. Estimated cost $65,000. H. H. Briggs, Ohio Hartman Bldg., is engineer. Owner is in the market for three 120 hp. steam boilers.

O., Willoughby—City Ice & Fuel Co., 1935 Euclid Ave., Cleveland, plans the construction of an ice manufacturing plant here. Estimated cost $85,000. Private plans.

Okla., Muskogee—Southern Ice & Utilities Co. has acquired the plants of the Crystal Ice Co. and the Southern Fish & Oyster Co. and plans to expend $150,000 for improvements to same.

Okla., Talihina — McCurtain Light & Power Co., plans the construction of an electric light plant. Estimated cost $40,000. Private plans. Machinery will be required.

Pa., Philadelphia—Huntingdon Hall, c/o F. H. Smith Co., 1524 Walnut St., is receiving sub-bids for the construction of a 16 story apartment and stores building at 20th and Walnut Sts. Estimated cost $1,500,000. Private plans.

Pa., Philadelphia—Parkway Apartment Corp., c/o F. N. Greissler, 1035 Walnut St., Archt., awarded contract for the construction of a 14 story apartment including swimming pool, 4 elevators, etc., at 33rd and Columbia Sts., to B. Bornstein, 1310 Winghocking Ave. Estimated cost $1,750,000.

Tenn., Knoxville — City, F. A. Ault, Recorder, will receive bids until Feb. 16 for the construction of a pumping station and filter plant including two 15,000,000 gal. turbo centrifugal pumps, two 18,000,000 gal. motor-driven centrifugal pumps, one 4,000,000 gal. motor-driven centrifugal pump, two 500 hp. water tube boilers, 300 lbs. pressure, 2 boiler feed pumps, 150,000 gal. steel wash water tank, switchboard, etc. Alvord, Burdick & Howson, are engineers.

Texas—Magnolia Petroleum Co., Beaumont, is having plans prepared for the construction of several pumping stations and a pipe line from Eldorado, Ark., to Beaumont, Tex., a distance of approximately 350 miles. Estimated cost $3,000,000. Private plans.

Tex., Abilene — Abilene State Hospital, T. B. Bass, Supt., will soon award contract for the construction of a 12 ton ice plant. Estimated cost $25,000. W. Nichol and G. F. Campbell, 29-30 Radford Bldg., are engineers.

Tex., Asherton—Texas Central Power Co., S. M. Udden, Mgr., Frost Bldg., San Antonio, plans the construction of an electric light plant here. Estimated cost $35,000.

Tex., Three Rivers—Texas Central Power Co., S. M. Udden, Frost Bldg., San Antonio, subsidiary of the Middle West Utilities Co., 72 West Adams St., Chicago, Ill., has acquired a power plant and is having surveys made for improvements including the installation of an engine, dynamos, etc., here. Estimated cost $75,000. Private plans.

Vt., Bellows Falls—New England Power Co., 35 Harvard St., Worcester, is having preliminary plans prepared for the construction of a power house and canal here. Estimated cost $3,000,000. Private plans.

Wis., Milwaukee — Metropolitan Sewage Comn., J. H. Fowles, Secy., 508 Market St., will receive bids until Feb. 13 for two 500 g.p.m. motor operated, float controlled centrifugal pumps, for Mud Creek low level sewage booster station. Former bids rejected.

Wis., Thiensville—Ladwig Sand & Gravel Co., Green Bay Road and Adams Ave., Milwaukee, is in the market for conveyors and motors for gravel pit here.

Alta., Kananaskis — Calgary Power Co., Calgary, plans to expend $100,000 for the installation of a new 20,000-kva. outfit of four separate transformers at Horseshoe plant, here.

Ont., Ottawa—Noffke, Morin & Sylvester, Elgin St., Archts., will soon receive bids for the construction of an 11 story hotel on Metcalfe St. Estimated cost $1,500,000. Owner's name withheld.

Que., Quebec City—Canadian Pacific R.R., Montreal, awarded contract for rebuilding section of "Chateau Frontenac" hotel recently destroyed by fire here, to Anglin-Norcross Ltd., 65 Victoria St., Montreal. Estimated cost $2,000,000.

Que., St. Didace—O. Dufresue et al, Maisonneuve, plans a hydro-electric development at St. Ursule Falls and Lauzon Falls on the Maskinonge River here, 100,000 hp. capacity. Estimated cost $150,000.

Que., Shawenegan Falls—Shawenegan Water & Power Co., Ltd., plans the construction of a new electric unit to power plant and renewing 14 ft. penstock. Estimated cost $2,000,000. R. C. Lindsay is engineer.

Mexico, Guadalajara—Morrison & McCall Co., Frost Bldg., San Antonio, Tex., has acquired the plant of the Compania Electrica del Chapala, Mexico City, and is having surveys made for improvements to increase the capacity from 26,500 to 100,000 hp. here.

PRICES - MATERIALS - SUPPLIES

Electrical prices on following page are prices to the power plant by jobbers in the larger buying centers east of the Mississippi. Elsewhere the prices will be modified by increased freight charges and by local conditions.

SINCE LAST MONTH

DECLINES predominate in the current market, comparing prices with those of a month ago. Linseed oil is off about 5½c. per gal. and babbitt metal, 2½c. per lb. In electrical supplies, the principal declines were in No. 14, two conduit, armored cable; flexible cord, except Canvasite; 25 and 100 watt "A" lamps, together with several other types. Wiping cloths continue firm with an upward trend.

POWER-PLANT SUPPLIES

HOSE—Quotations at New York warehouses:

Fire Protection			50-Ft. Lengths
Underwriters' 2½-in., coupled, single jacket			71c. per ft.
Common, 2½-in., cotton-rubber lined			.80c. per ft. list less 45%
Air—Best grade			
¾-in., per ft.	3-ply	$0.37½	4 ply $0.46
Steam—Discounts from List			
First grade .30–10%	Second grade .40%		Third grade .40–10%

RUBBER BELTING—List price 6-in., 6 ply, $1.83 per lin.ft. The following discounts from list apply to rubber transmission belting:

Best grade 50% Second grade 50–10%

LEATHER BELTING—List price, 24c. per lin.ft. per inch of width for single ply at New York warehouses.

Grade	Discount from list
Medium	40–5%
Heavy	30–10%

RAWHIDE LACING—For cut, best grade, 50%, 2nd grade, 60%. For laces in sides, best, 41c. per sq.ft.; 2nd, 37c. Semi-tanned: cut, 50%; sides, 41c. per sq.ft.

PACKING—Prices per pound at New York warehouses:

Rubber and duck for low-pressure steam, ⅛ in.	$1.05
Asbestos for high-pressure steam, ⅛ in.	1.85
Duck and rubber for piston packing	1.05
Flax, regular	1.15
Flax, waterproofed	1.70
Compressed asbestos sheet	.95
Wire insertion asbestos sheet	1.40
Rubber sheet	.60
Rubber sheet, wire insertion	.85
Rubber sheet, duck insertion	.65
Rubber sheet, cloth insertion	.30
Asbestos packing, twisted or braided and graphited, for valve stems and stuffing boxes	1.40
Asbestos wick, ½- and 1-lb. balls	.50

PIPE AND BOILER COVERING—Discounts, New York warehouses, are as follows:

85% magnesia high pressure		50%
For low-pressure heating and return lines	4-ply	70%
	3-ply	72%
	2-ply	74%

PORTLAND CEMENT—New York, $2.50@ $2.70 per bbl. without bags, in carload lots delivered on job. Bag charge of 40c. per bbl.

STRUCTURAL STEEL—New York delivered price, 3 to 15-in. beams and channels and 3 to 6-in. angles, tees, and plates, all $3.34 per 100 lb.

COTTON WASTE—The following prices are in cents per pound:

	New York	Cleveland	Chicago
White	15.00@22.00	19.00	20.00
Colored	10.00@15.50	10.00	17.00

WIPING CLOTHS—Prices per pound in lots of about 600 lb., for washed, white wipers, as follows:

Chicago	$0.16
New York	.18
Cleveland (per thousand)	36.00

LINSEED OIL—These prices are per gallon:

	New York	Cleveland	Chicago
Raw in barrels (5 bbl. lots)	$0.88½	$1.05	$0.90

WHITE AND RED LEAD—Per 100-lb. keg, base price, f.o.b. New York:

	Dry		In Oil	
	Current	1 Yr. Ago	Current	1 Yr. Ago
Red	$15.25	$16.25	$16.75	$17.75
White	15.25	16.25	15.25	16.25

RIVETS—The following quotations are allowed for fair-sized orders from warehouse:

Rivets, ¼x1-in. and longer, 19c. per lb., less 50% at New York warehouses. Same discount for tinned. EXTRA per 100 lb. for 1½ to 2-in. long, all diameters, 25c.; ⅝-in. dia., 35c.; ¾-in., dia., 75c.; 1-in. long and shorter, 75c.; longer than 5-in., 50c.; less than 200 lb., 50c.; countersunk heads, 45c.

Structural rivets, ¾, ⅞, 1 in. diameter by 2½ in. to 4½ in. sell as follows per 100 lb.:

New York $5.00* Chicago $3.50 Pittsburgh $2.60

Boiler rivets, same sizes:

New York $5.20* Chicago $3.70 Pittsburgh $2.90

* For immediate delivery from warehouse.

REFRACTORIES—Prices in carlots f.o.b.; last:

Chrome brick, eastern shipping points	net ton	$48@53
Chrome cement, 40@ 50% Cr_2O_3, in bulk	net ton	23@28
Chrome cement, 40@ 50% Cr_2O_3, in sacks	net ton	27@32
Magnesite brick: 9-in. straights	net ton	65@68
Magnesite brick: 9-in. arches, wedges and keys	net ton	71.50@74.80
Magnesite brick: Soaps and splits	per ton	91.00@95.20
Silica brick: Mt. Union, Pa.	per M	38@40
Clay brick, 1st quality, 9 in. shapes, Pennsylvania	per M	40@47
Clay brick, 1st quality, 9 in. shapes, Ohio	per M	43@46
Clay brick, 1st quality, 9 in. shapes, Kentucky	per M	43@45
Clay brick, 1st quality, 9 in. shapes, Maryland	per M	48@50
Clay brick, 2nd quality, 9 in. shapes, Pennsylvania	per M	33@40
Clay brick, 2nd quality, 9 in. shapes, Ohio	per M	40@43
Clay brick, 2nd quality, 9 in. shapes, Kentucky	per M	40@43
Clay brick, 2nd quality, 9 in. shapes, Maryland	per M	43@45
Chrome ore crude, 40@ 50%	net ton	19.00@20.50

BABBITT METAL—Delivered, New York, cents per lb.:

Genuine, highest grade	78.00
Commercial genuine, intermediate grade	56.00
Anti-friction metal, general service	31.50
No. 4 babitt (f.o.b.)	14.50

COLD DRAWN STEEL—Warehouse prices are as follows:

	New York	Cleveland	Chicago
Round shafting and screw stock, per 100 lb. base	$4.00	$3.90	$3.60
Flats and squares, per 100 lb. base	4.50	4.40	4.10

BOILER SPECIALTIES—F. o. b. New York or Jersey City, discounts on list:

	Current
Copper ferrules	70%
Boiler flanges	60–10%
Boiler stay bolts	60%
Boiler patch bolts	10%
Boiler fitting-up bolts	45%
Pressed steel boiler lugs	10%

WROUGHT PIPE—The following discounts are to jobbers for carload lots at Pittsburgh mill:

BUTT WELD

Inches	Steel Black	Steel Galv.	Inches	Iron Black	Iron Galv.
1 to 3	62	50½	1 to 1½	30	13
LAP WELD					
2	55	43½	2	23	7
2½ to 6	59	47½	2½	26	11
7 and 8	56	43½	3 to 6	28	13
9 and 10	54	41½	7 to 12	26	11
11 and 12	53	40½			
BUTT WELD, EXTRA STRONG, PLAIN ENDS					
1 to 1½	60	49½	1 to 1½	36	14
2 and 3	61	50½			
LAP WELD, EXTRA STRONG, PLAIN ENDS					
2	53	42½	2	23	9
2½ to 4	57	46½	2½ to 4	29	15
4½ to 6	56	45½	4½ to 6	28	14
7 and 8	52	39½	7 and 8	21	7
9 and 10	45	32½	9 to 12	16	2
11 and 12	44	31½			

BOILER TUBES—Following are prices in New York warehouse of tubes manufactured according to specifications of the American Society of Mechanical Engineers:

Size	Lapweld Steel	C. C. Iron	Seamless Steel
1	.....	.....	$17 07
1¼	.....	.....	19 20
1½	.....	$38 00	17 92
1¾	.....	28 50	20 48
2	$17 33	25 00	20 24
2¼	19 84	28 25	23 00
2½	21 60	34 00	26 03
3	25 50	42 50	27 04
3¼	30 25	49 50	30 67
3½	31 50	52 75	33 33
4	38.03	67 00	40.11

Tubes 2¼ in. diameter, or smaller, over 18 ft. long, 10 per cent extra.
These prices are net per 100 ft. based on stock lengths. If cut to special lengths, billing will be based on the entire stock lengths.
In addition to the above, standard cutting charges are as follows:
2 in. and smaller, 5c. per cut. 3 in., 9c. per cut
2¼ and 2½ in., 6c. per cut. 3¼ to 4 in., 10c. per cut

ELECTRICAL SUPPLIES

ARMORED CABLE—Price per 1,000 ft.—5 per cent 10 days.

B. & S. Size	Two Cond. M Ft.	Three Cond. M Ft.	Two Cond. Lead M Ft.	Three Cond. Lead M Ft.
No. 14 solid	$35.00 (net)	$56.00 (net)	$164.00	$210.00
No. 12 solid	135.00	170.00	225.00	265.00
No. 10 solid	185.00	235.00	275.00	325.00
No. 8 stranded	285.00	375.00	520.00	500.00
No. 6 stranded	400.00	500.00	560.00	.....

From the above lists discounts are:

		Lead Covered
Less than coil lots	50%	20%
Coils to 1,000 ft.	55%	25%
1,000 to 5,000 ft.	60%	30%
5,000 ft. and over	60–5%	35%

CONDUIT, Price per 1,000 ft.; **ELBOWS AND COUPLINGS**, Per 100 pieces, f.o.b. New York, with 10-day discount of 5 per cent.

Size In.	Conduit Black Per M	Conduit Galvanized Per M	Elbows Black Per C	Elbows Galvanized Per C	Couplings Black Per C	Couplings Galvanized Per C
¼	$56 50	$61 34	$7.76	$8.83	$4.52	$4.92
⅜	72.07	78.63	10.21	11.63	6.46	7.03
½	103.31	113.00	15.10	17.21	8.39	9.13
¾	139.77	152.88	20.51	23.07	11.78	12.75
1	167.12	182.79	27.34	30.76	14.56	15.75
1¼	224.85	245.94	50.15	56.40	19.41	21.01
1½	355.50	388.85	82.05	92.28	27.73	30.01
2	464.88	508.50	218.74	246.10	41.59	45.01
2½	585.30	637.74	483.04	543.46	55.46	60.02
3	714.17	776.30	558.23	628.06	69.32	75.02

CONDUIT BODIES AND FITTINGS—Black or galvanized.

	Less than $10 list	$10 list to $100	$100 list and over
Standard package	10%	20%	28%
Less than standard package	5%	10%	20%

CUT-OUTS—Following are net prices each in standard-package quantities:

CUT-OUTS, PLUG, SOLID NEUTRAL OR 2 FUSE

S. P. M. I.	$0.12	D. P. D. B.	$0.31
D. P. M. I.	.16	T. P. S. B.	.35
T. P. M. I.	.27	T. P. D. B.	.47
D. P. S. B.	.16		

CUT-OUTS, N. E. C. FUSE, SOLID NEUTRAL OR 2 FUSE

	0-30 Amp.	31-60 Amp.	60-100 Amp.
D. P. M. I.	$0.27	$0.70	$1.75
T. P. M. I.	.40	1.00	2.30
D. P. S. B.	.35	.87	.....
T. P. S. B.	.67	1.50	.....
D. P. D. B.	.65	1.75	.....
T. P. D. B.	1.12	3.00	.....
T. P. to D. P. D. B.	.75	2.10	.....

FLEXIBLE CORD—Price per 1,000 ft. in coils of 250 ft.:

No. 18 cotton reinforced heavy		$21.50
No. 16 cotton reinforced heavy		25.00
No. 18 cotton reinforced light		17.50
No. 16 cotton reinforced light		21.00
No. 18 cotton Canvasite cord		17.25
No. 16 cotton Canvasite cord		21.00
No. 16 super service cord or similar (2 wire) in 1,000 ft.	$92.00	*101.20
No. 14 super service cord or similar (2 wire) in 1,000 ft.	133.00	*146.40

*Less than 1,000 ft.

NATIONAL ELECTRIC CODE FUSES, NON-REFILLABLE—

250-Volt	Std. Pkg.	List	600-Volt	Std. Pkg.	List
3-amp. to 30 amp.	100	$0.15	3-amp. to 30-amp.	100	$0.30
35-amp. to 60-amp.	100	.30	35-amp. to 60-amp.	100	.60
61-amp. to 100 amp.	50	.90	65-amp. to 100-amp.	50	1.50
101-amp. to 200-amp.	25	2.00	110-amp. to 200-amp.	25	2.50
201-amp. to 400-amp.	25	3.60	225-amp. to 400-amp.	25	5.50
401-amp. to 600-amp.	10	5.50	450-amp. to 600-amp.	10	8.00

Discount: Less 1-5th standard package, 60%; 1-5th to standard package, 65%; standard package, 70%.

RENEWABLE FUSES, ENCLOSED—List price each:

Sizes	250-Volt List-Price	600-Volt List-Price	Std. Pkg. Quantity	Carton Quantity
1 to 30-amp.	$0.50	$1.10	100	10
35 to 60-amp.	1.00	1.25	100	10
65 to 100-amp.	2.00	3.00	50	5
110 to 200-amp.	4.00	5.00	25	5
225 to 400-amp.	7.50	11.00	25	1
450 to 600-amp.	11.00	16.00	10	1
450 to 600-amp.	11.00	16.00	10	1

REFILLS—

1 to 30	$0.30 ea.	$0.05	100	100
35 to 60	.05 ea.	.06	100	100
65 to 100	.10 ea.	.10	50	50
110 to 200	.15 ea.	.15	25	50
225 to 400	.30 ea.	.30	25	25
450 to 600	.60 ea.	.60	10	10

Discount Without Contract—Fuses:

Broken carton	5%
Unbroken carton but less than std. pkg.	22%
Std. pkg.	40%
Discount Without Contract—Renewals:	
Less than std. pkg.	Net list
Standard package	40%
Discount With Contract—Fuses:	
Broken cartons	10%
Unbroken cartons but less than standard package	26%
Standard package	42%
Discount With Contract—Renewals:	
Less standard package	Net list
Standard package	42%

FUSE PLUGS, MICA CAP OR CLEARSITT—

0-30 ampere, standard package (500)	$2.85
0-30 ampere, less than standard package	3.15

LAMPS—Below are present quotations in less than standard package quantities:

Straight-Side Bulbs Mazda B— Watts	Plain	Frosted	No. in Package	Pear-Shaped Bulbs or Bowl Enameled Mazda C— Watts	Clear	Frosted	No. in Package
10	$0.27	$0.32	120	50	$0.40	$0.45	60
15	.27	.32	120	75	.45	.55	60
25	.27	.32	120	100	.50	.55	24
40	.27	.32	120	150	.65	.70	24
50	.27	.32	120	200	.80	.85	24
60	.32	.37	120	300	1.25	1.35	24
				500	2.00	2.15	12
				750	3.50	3.70	8
				1,000	3.75	3.95	8

Standard pkg. quantities are subject to discount of 10% from list. Annual contracts ranging from $75 to $300,000 net allow a discount of 15 to 40% from list.

PLUGS, ATTACHMENT—

	Each
Porcelain separable attachment plug	$0.18
Composition 2-piece attachment plug	.27
Swivel attachment plug	.12
Small size—2 Pc. Plug—Composition	08½

RUBBER-COVERED COPPER WIRE—Per 1000 ft. f. o. b. New York:

No.	Solid Single Braid	Solid Double Braid	Stranded, Double Braid	Duplex
14	$7.20	$9.95	$11.80	$18.50
12	10.25	12.98	14.97	24.55
10	13.50	16.90	18.90	31.76
8	18.90	22.90	24.40	42.75
6	.....	.....	35.00	.....
4	.....	.....	47.85	.....
2	.....	.....	68.75	.....
1	.....	.....	89.65	.....
0	.....	.....	120.16	.....
00	.....	.....	142.20	.....
000	.....	.....	169.90	.....
0000	.....	.....	202.67	.....

SOCKETS, BRASS SHELL—

½ In. or Pendant Cap Key Each	½ In. or Pendant Cap Keyless Each	½ In. or Pendant Cap Pull Each	¾ In. Cap Key Each	¾ In. Cap Keyless Each	¾ In. Cap Pull Each
$0.36	$0.33	$0.50*	$0.42	$0.39	$0.56*

Less 1-5th standard package	30%
1-5th to standard package	40%
Standard package	45%

* Net.

WIRING SUPPLIES—

Friction tape, ¾ in., less 100 lb. 35c. lb., 100 lb. lots	33c. lb.
Rubber tape, ¾ in., less 100 lb. 37c. lb., 100 lb. lots	35c. lb.
Wire solder, less 100 lb. 27c. lb., 100 lb. lots	29c. lb.
Soldering paste, 2 oz. cans	$1.00 doz.

ENCLOSED SWITCHES, KNIFE—Safety type, externally operated, 250 d.c or a.c., N.E.C.

TYPE "C" FUSED BOTTOM

Size, Amp.	Double Pole, Each	Three Pole, Each	Four Pole, Each
30	$4.50	$6.00	$7.25
60	7.50	8.25	10.50
100	10.50	13.00	22.50
200	16.00	20.00	36.00

Discounts:

Less than $25.00 list value	30%
$25 to $50 list value	30–5%
$50 list value or over	35%